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(54) **SYSTEM AND METHOD FOR SEALING HIGH INTENSITY DISCHARGE LAMPS**

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(51) **Int. Cl.**
H01J 17/22 (2006.01)
H01J 61/24 (2006.01)
H05B 1/00 (2006.01)

(52) **U.S. Cl.** **313/547**; 219/200; 219/485; 219/402; 219/405; 313/549

(58) **Field of Classification Search** .... None
See application file for complete search history.

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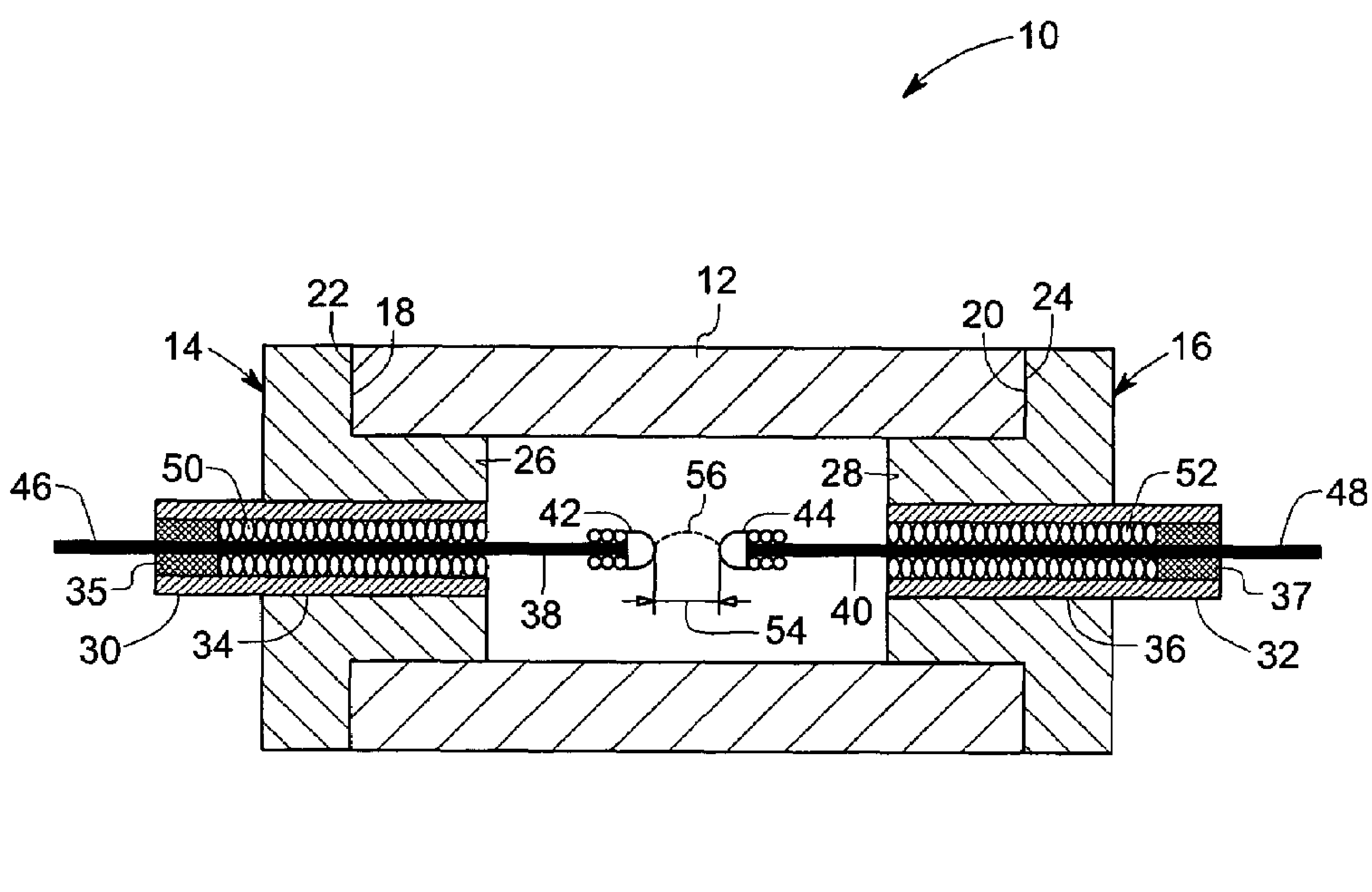
(74) *Attorney, Agent, or Firm*—Fletcher Yoder

(57) **ABSTRACT**

In accordance with certain embodiments, the present technique includes a system for sealing a lamp including a thermal shield and a thermally susceptible enclosure disposed adjacent the thermal shield. The thermal shield has a first receptacle adapted to receive a first portion of the lamp. The thermally susceptible enclosure comprises a wall about a second receptacle adapted to receive a second portion of the lamp. The wall has a varying thickness in a desired sealing region between the first and second portions of the lamp.

58 Claims, 15 Drawing Sheets



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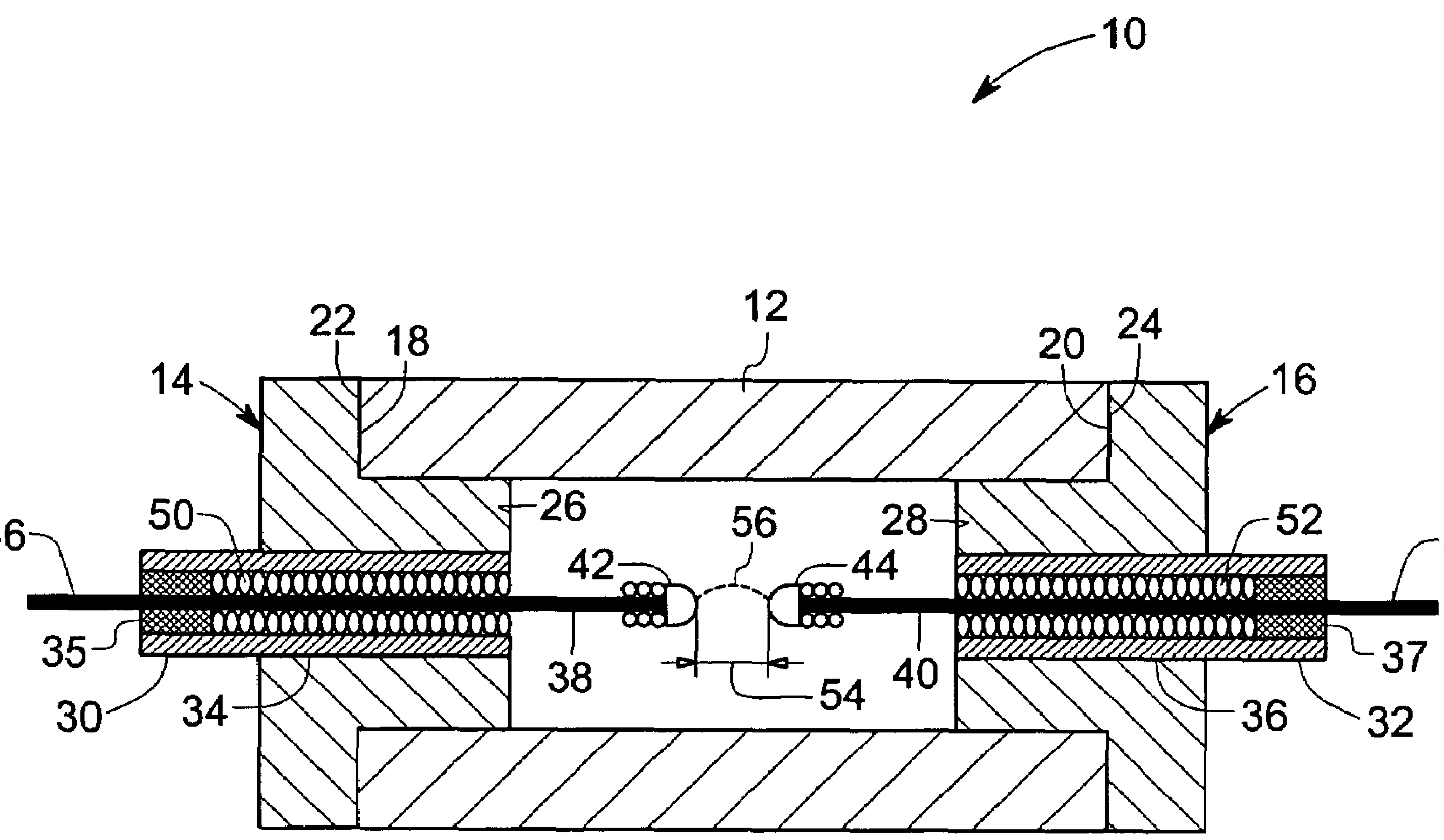
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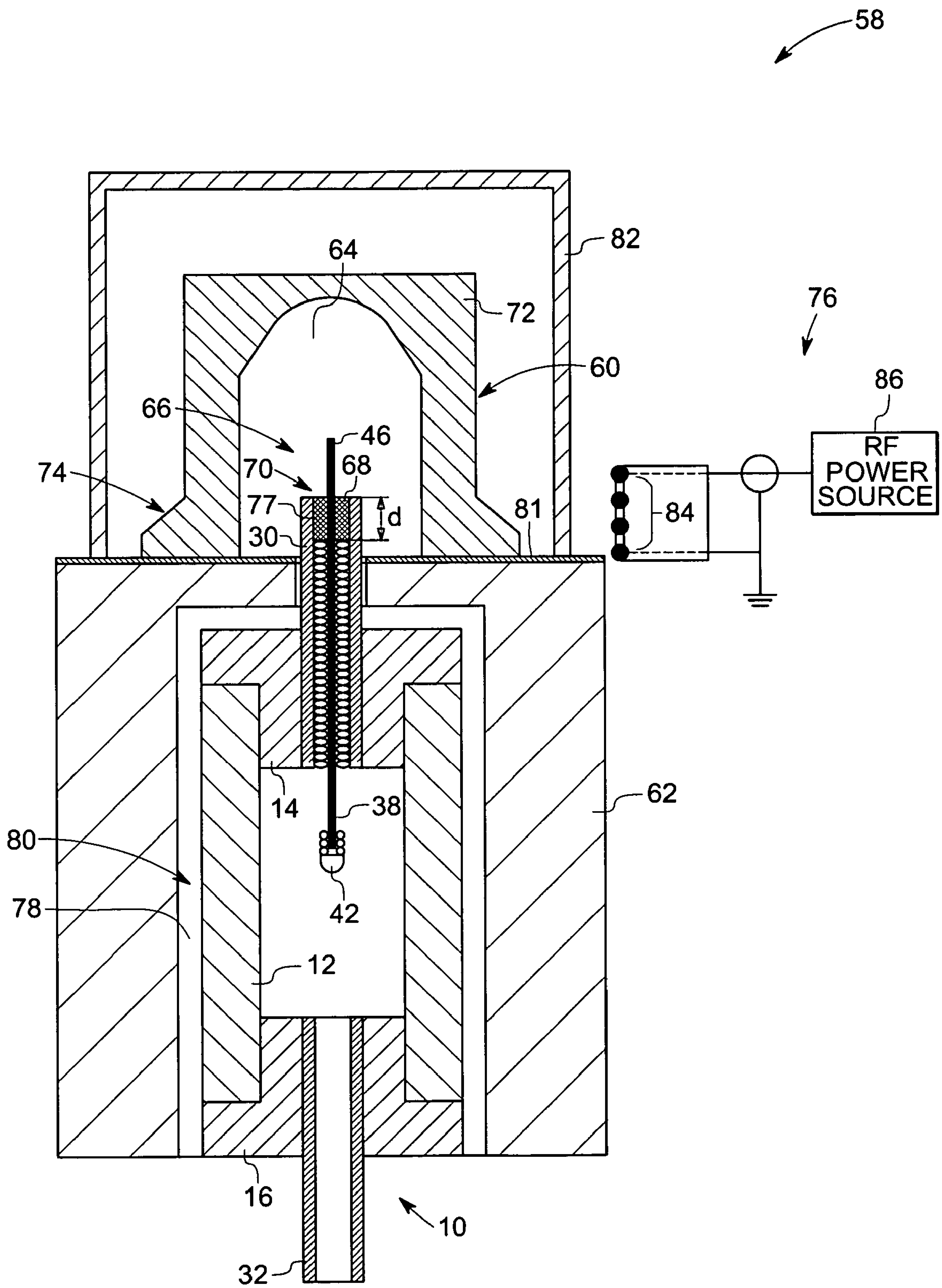
FIG.1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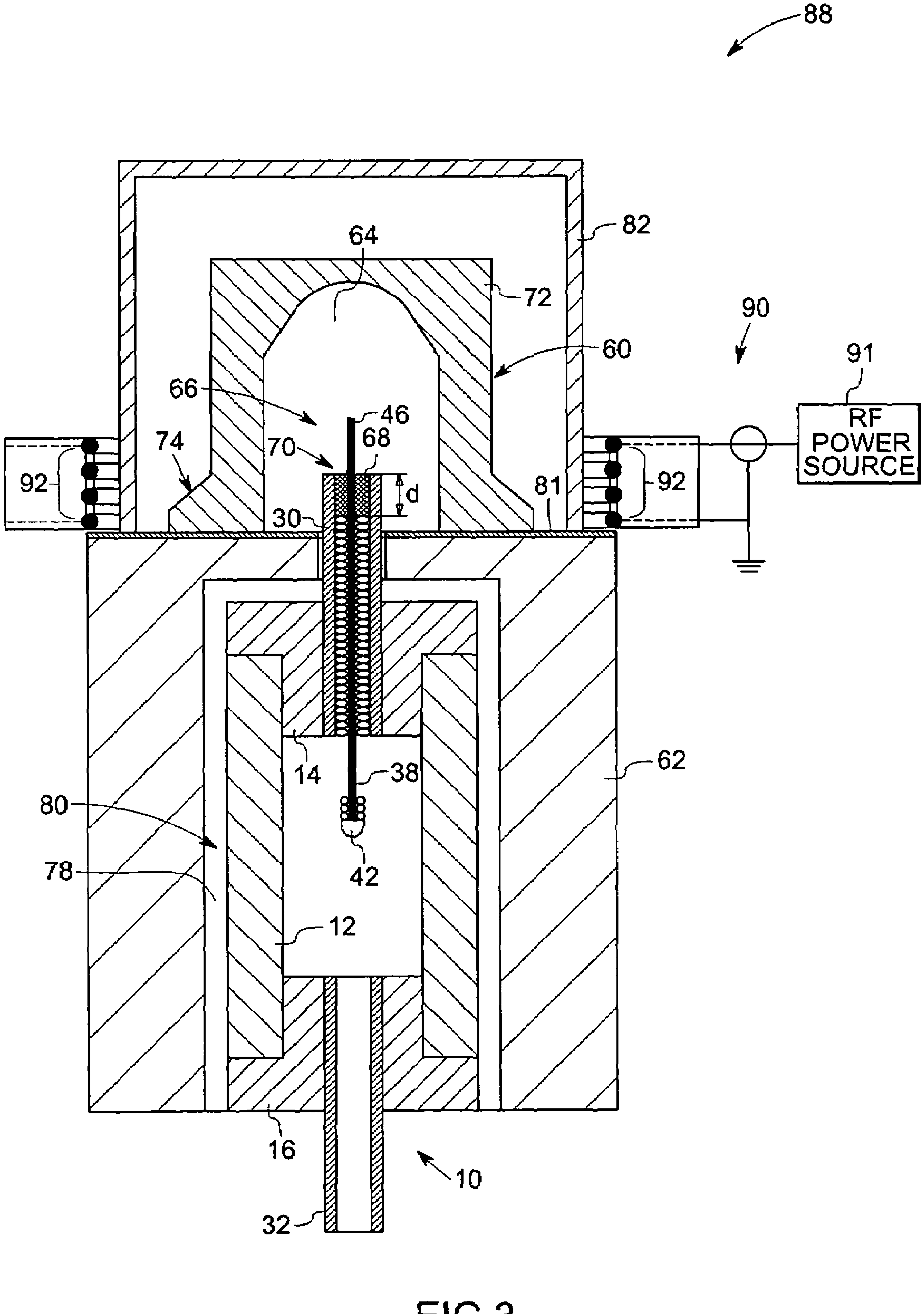
64
82
72
76
60
86
RF POWER SOURCE
66
46
74
70
68
77
d
81
84
30
14
38
62
80
42
78
12
16
10
32

FIG.2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32

FIG.3

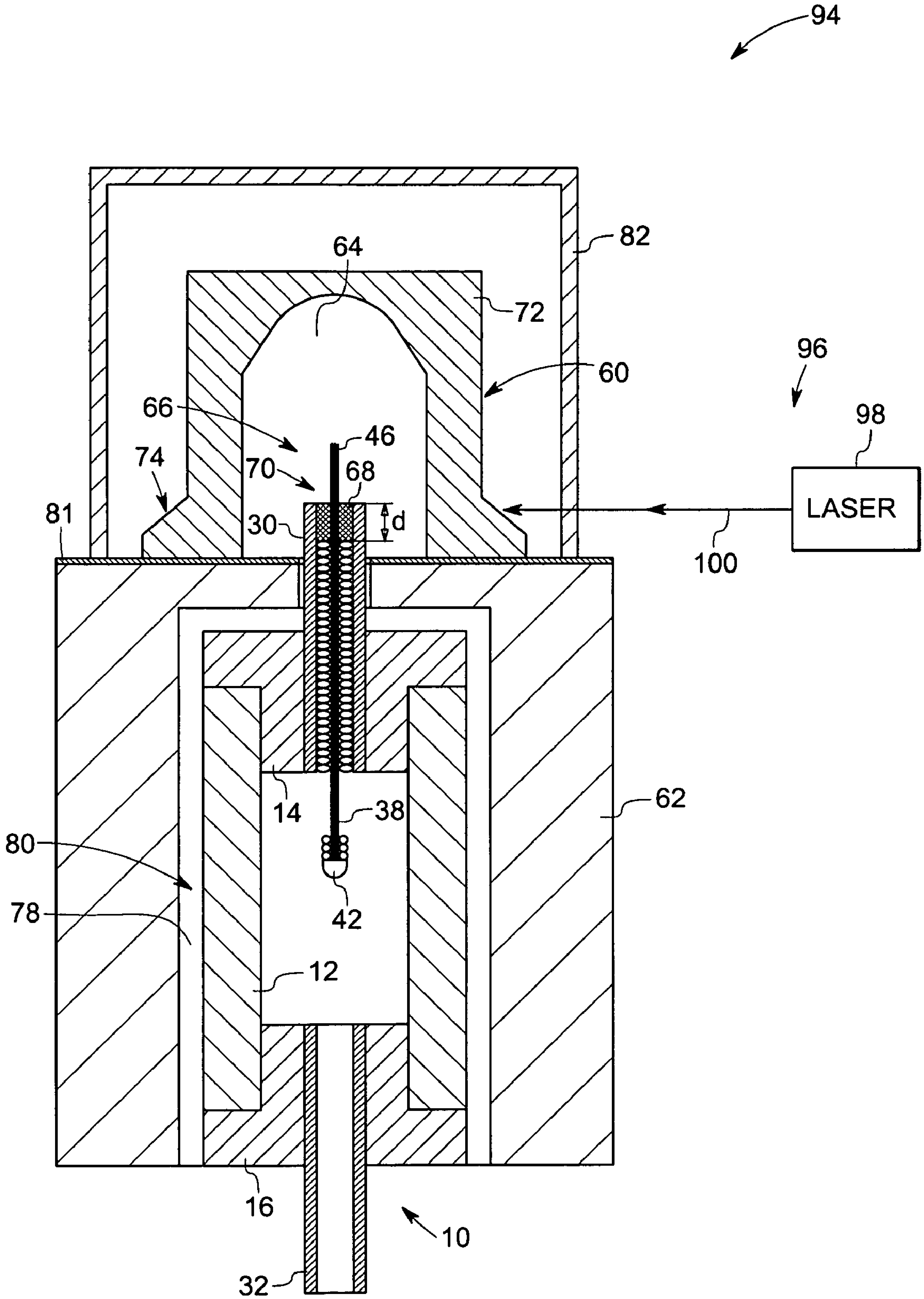
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FIG.4

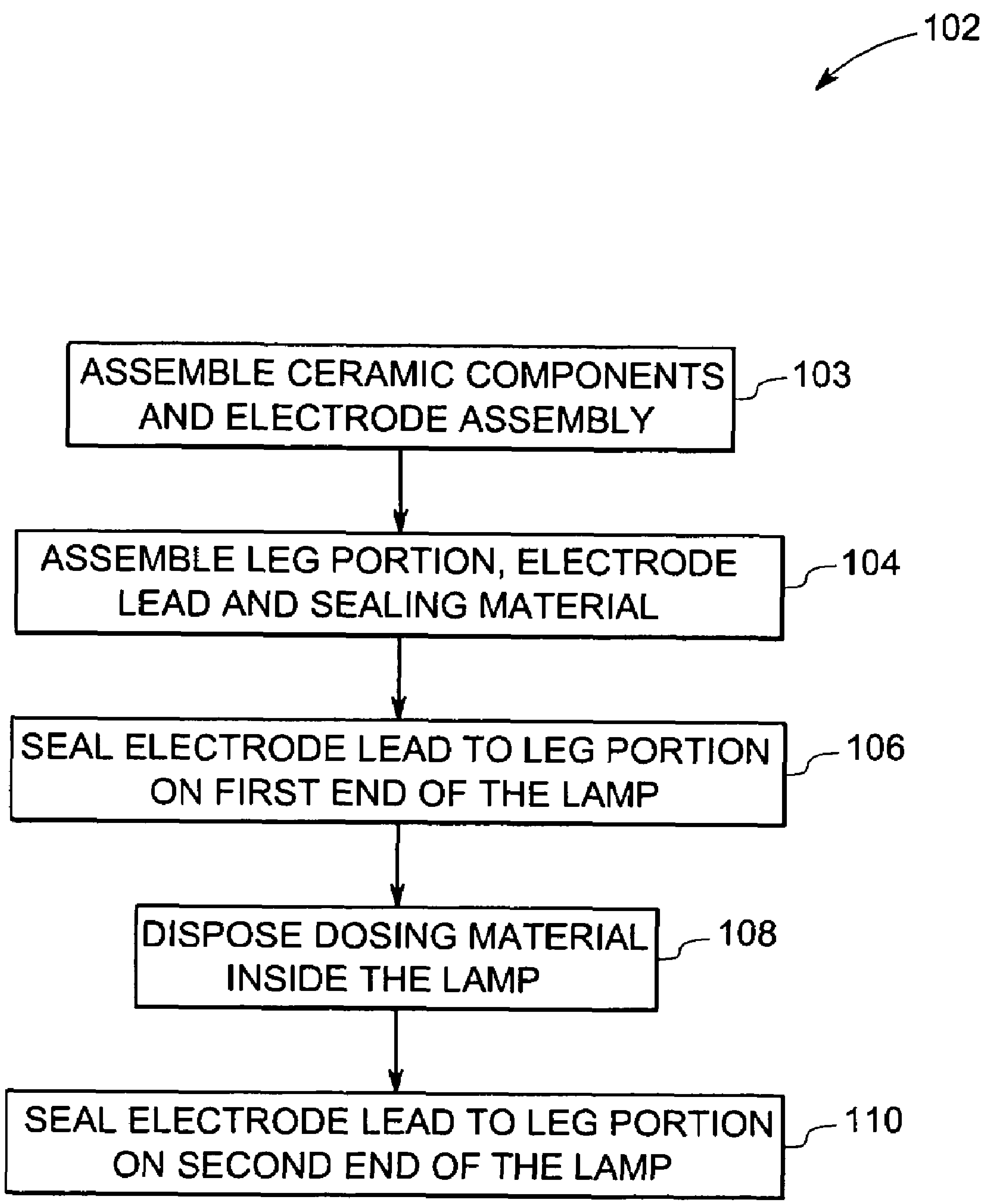
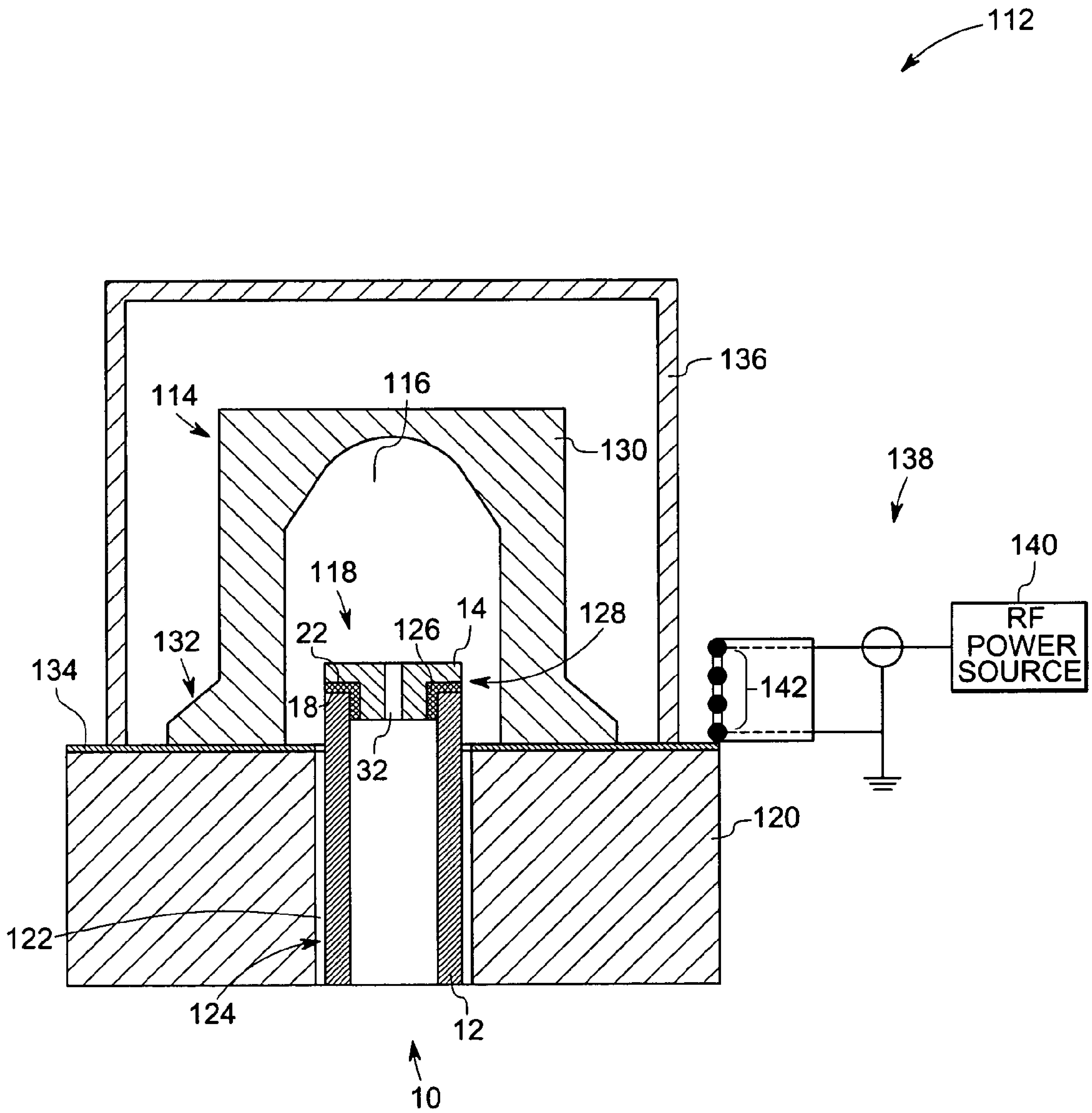

102
ASSEMBLE CERAMIC COMPONENTS AND ELECTRODE ASSEMBLY
103
ASSEMBLE LEG PORTION, ELECTRODE LEAD AND SEALING MATERIAL
104
SEAL ELECTRODE LEAD TO LEG PORTION ON FIRST END OF THE LAMP
106
DISPOSE DOSING MATERIAL INSIDE THE LAMP
108
SEAL ELECTRODE LEAD TO LEG PORTION ON SECOND END OF THE LAMP
110

FIG.5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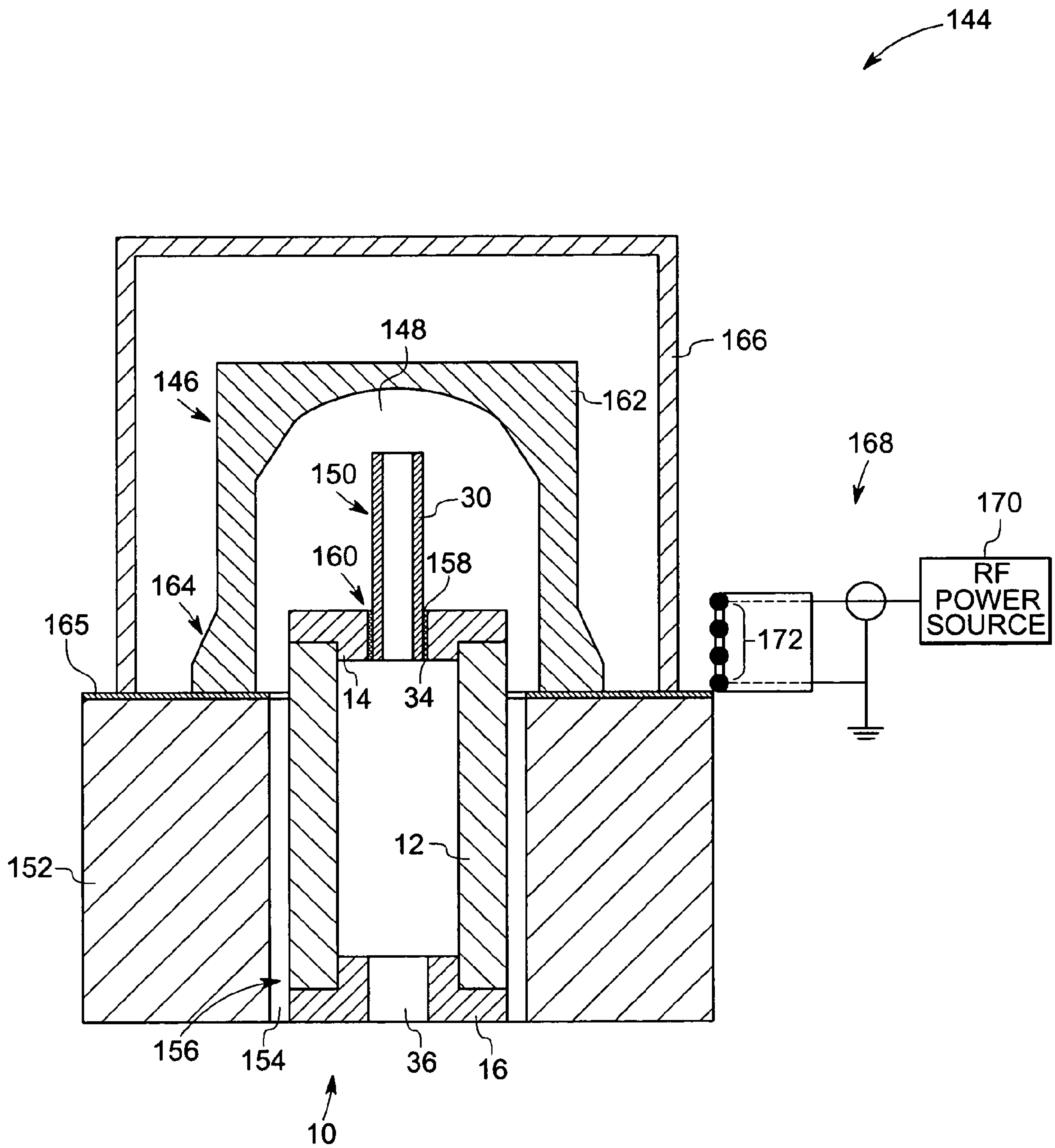
10

FIG.6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16
10

FIG.7

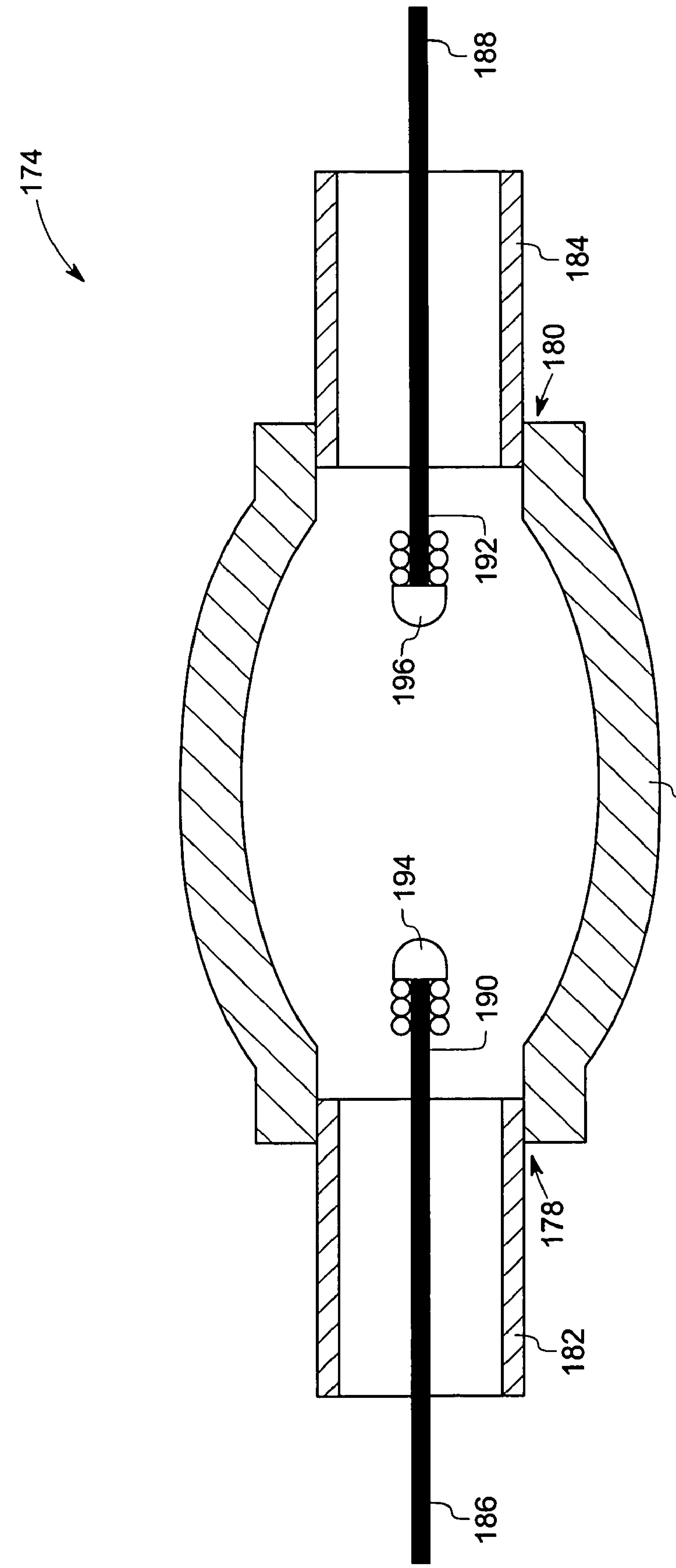

FIG.8

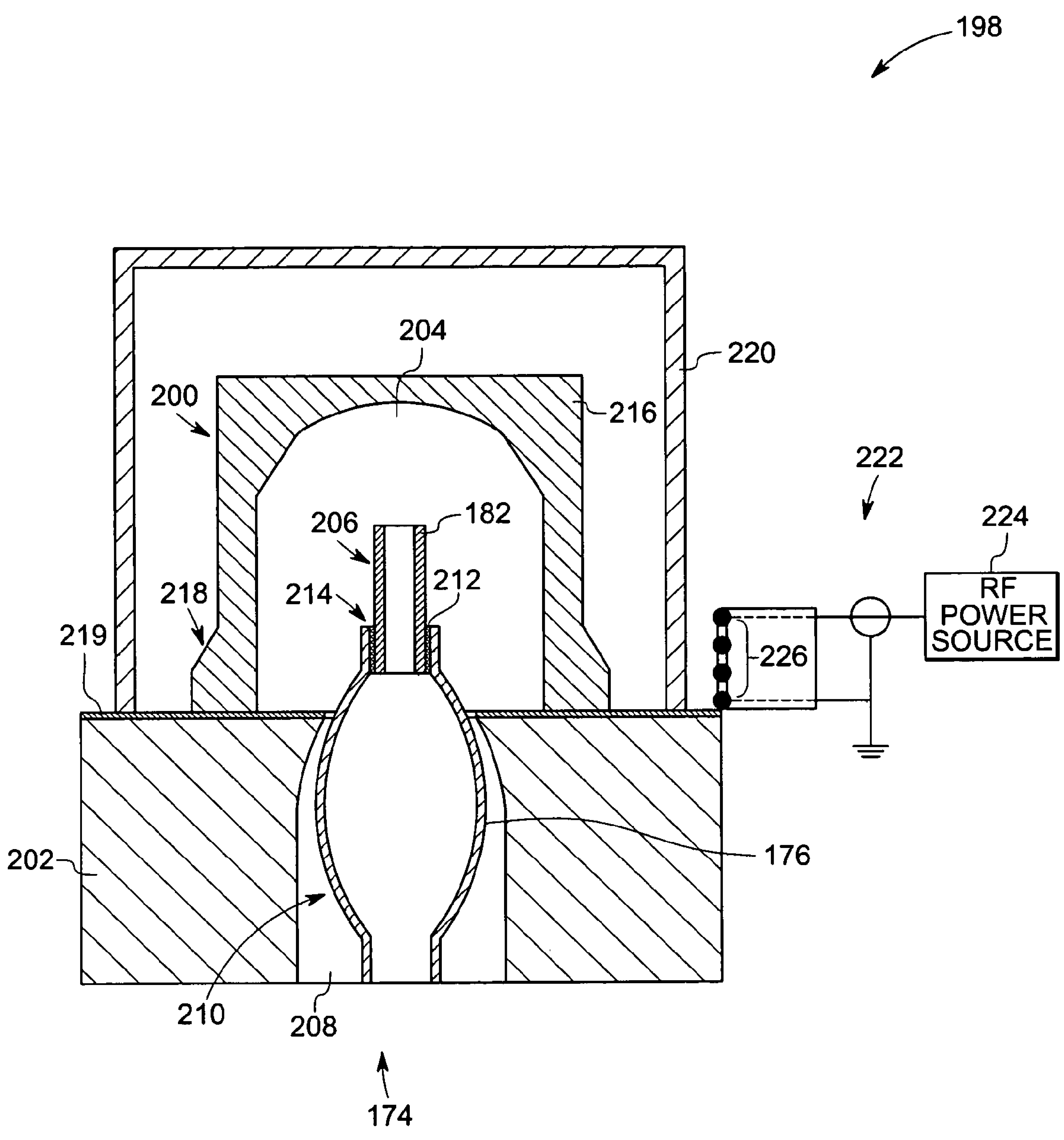
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FIG.9

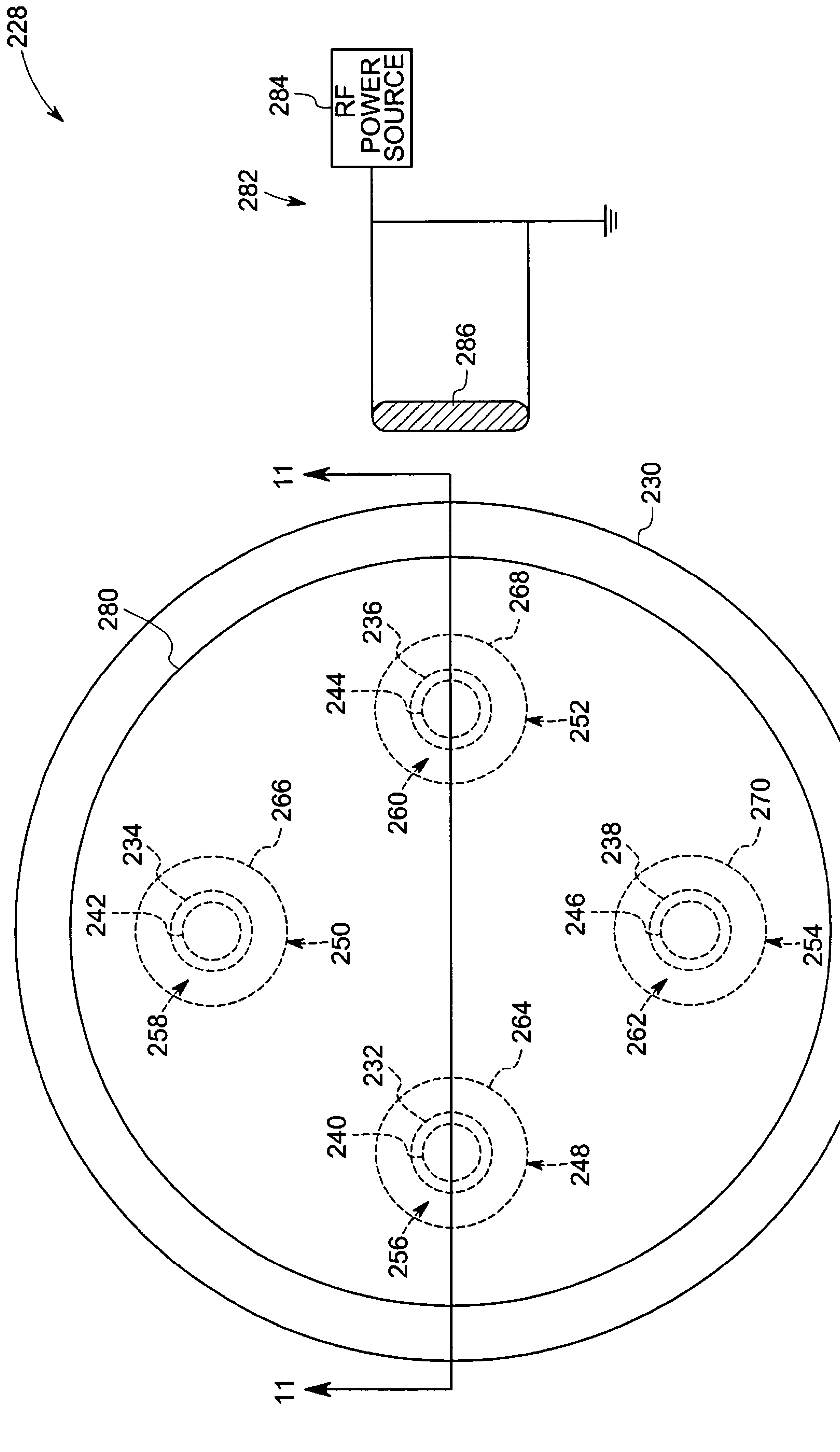
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FIG.10

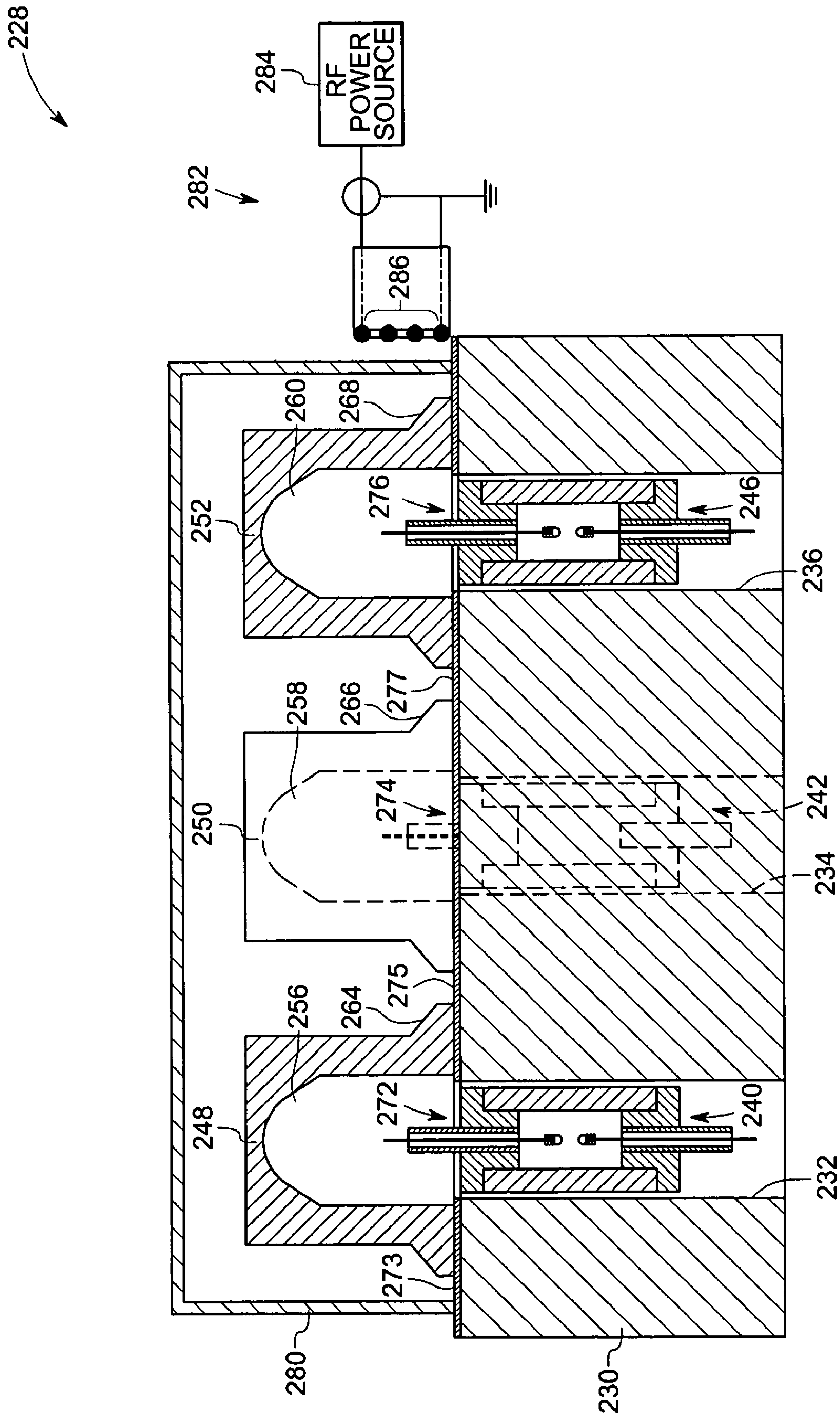
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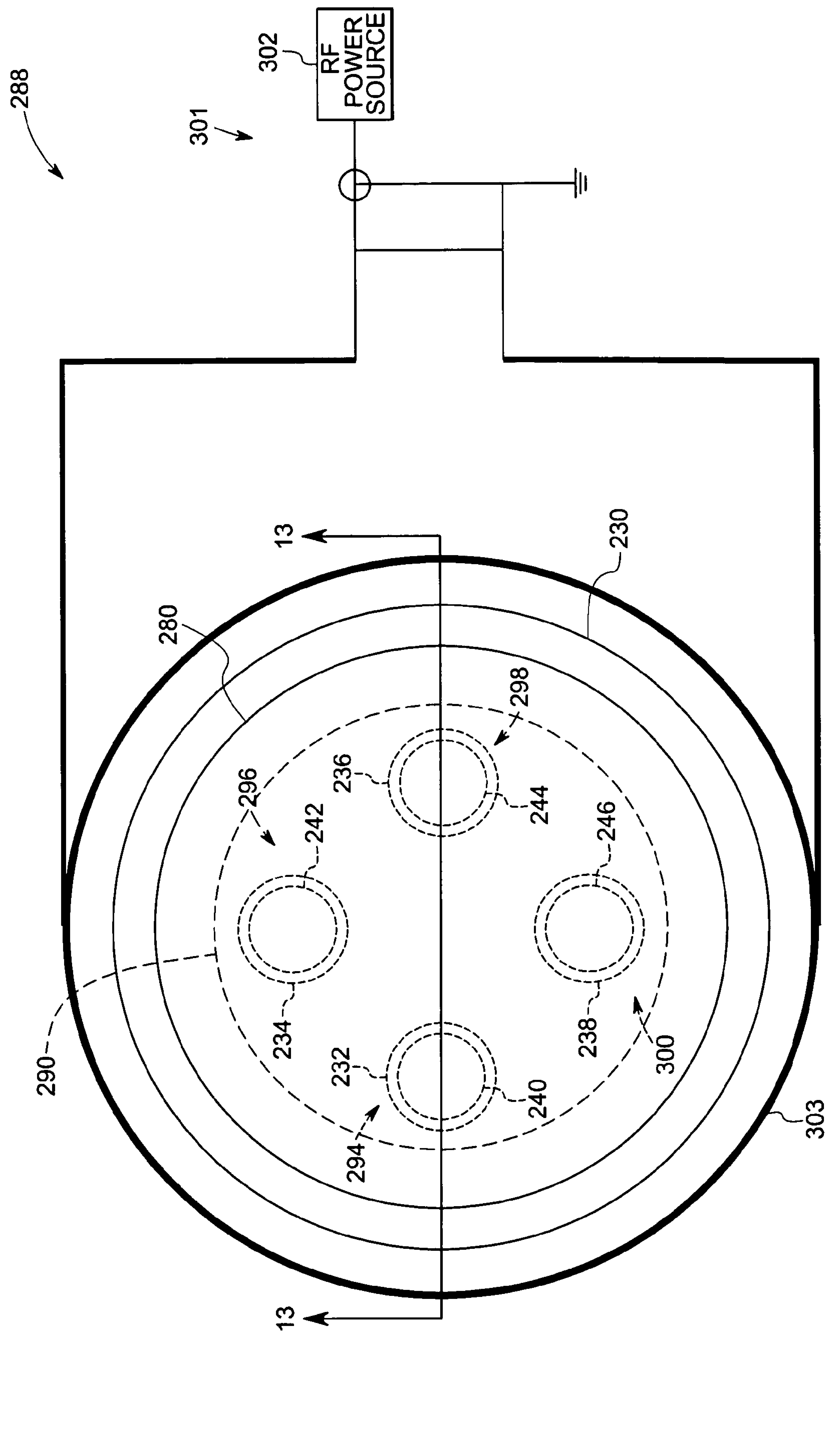
FIG.11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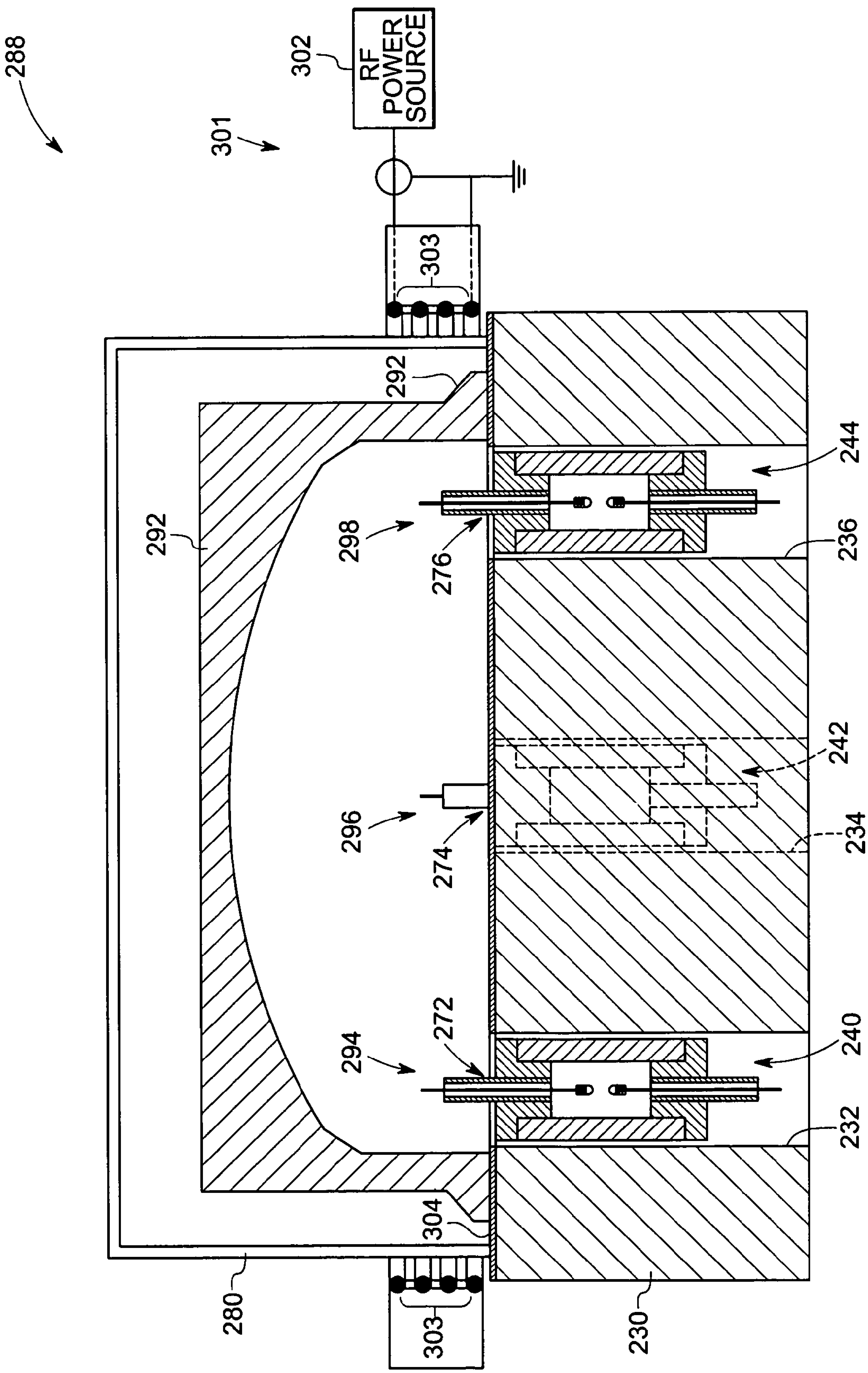
13

FIG.12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230

FIG.13

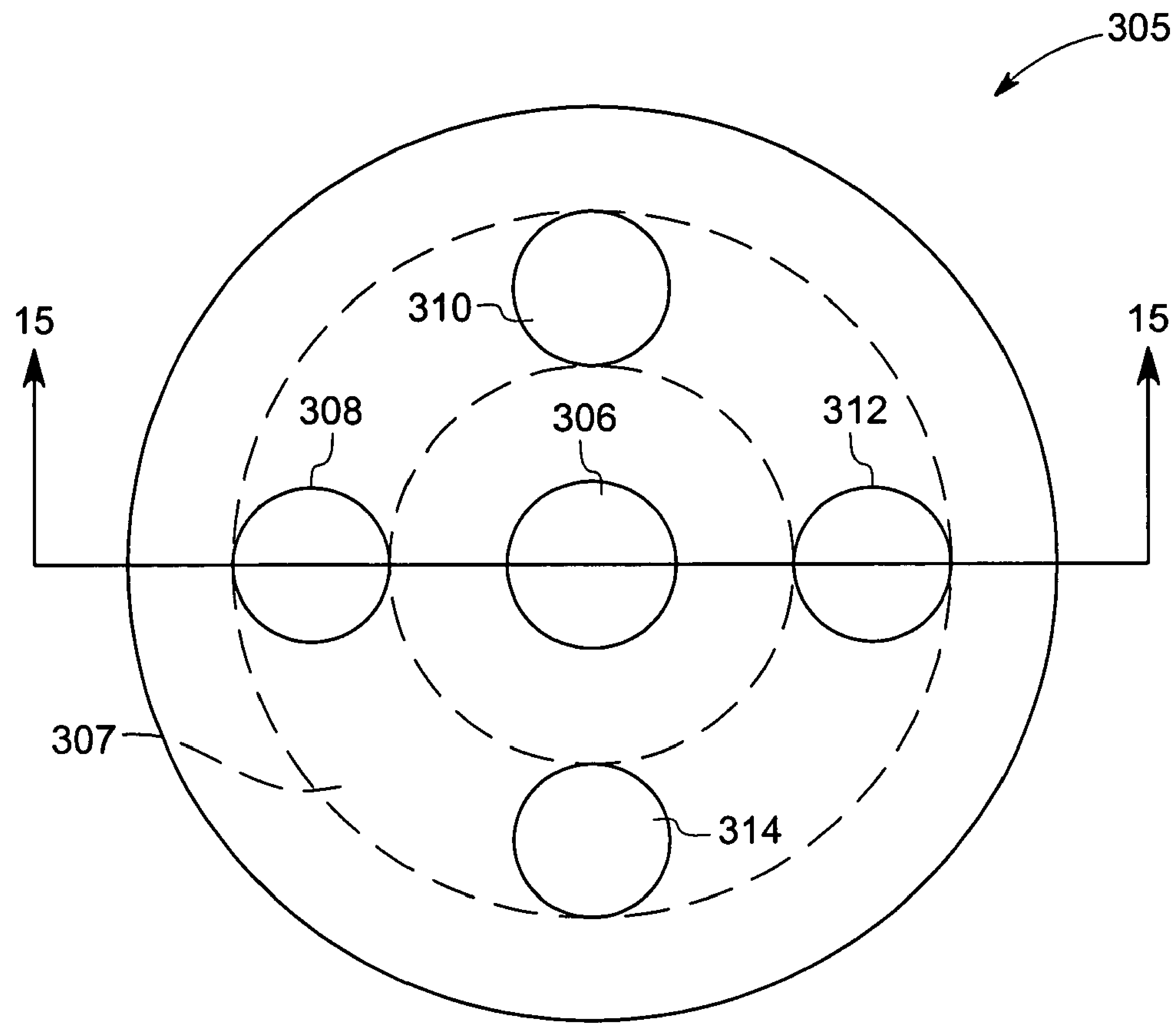
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FIG.14

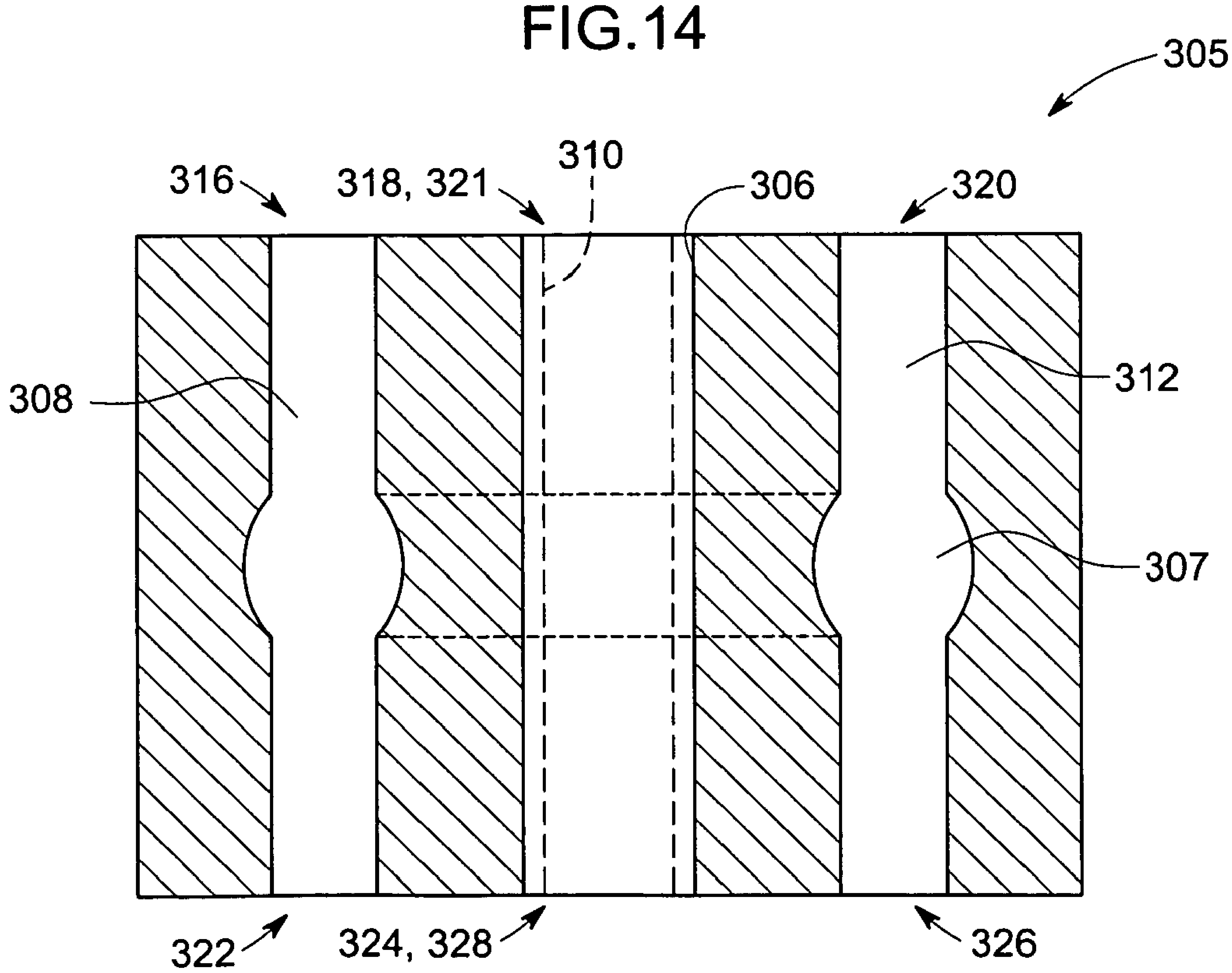
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FIG.15

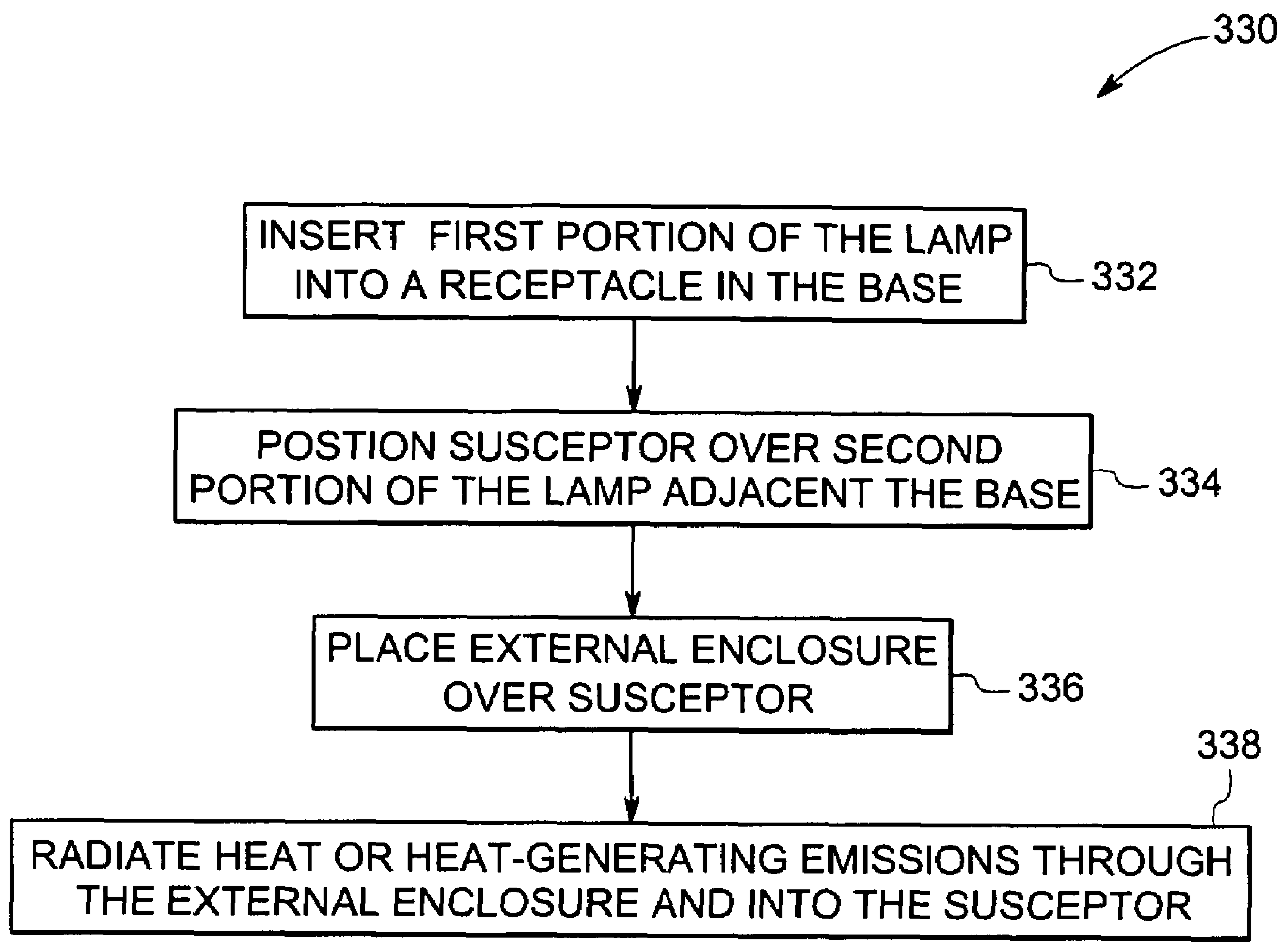
330
INSERT FIRST PORTION OF THE LAMP INTO A RECEPTACLE IN THE BASE
332
POSTION SUSCEPTOR OVER SECOND PORTION OF THE LAMP ADJACENT THE BASE
334
PLACE EXTERNAL ENCLOSURE OVER SUSCEPTOR
336
338
RADIATE HEAT OR HEAT-GENERATING EMISSIONS THROUGH THE EXTERNAL ENCLOSURE AND INTO THE SUSCEPTOR

FIG.16

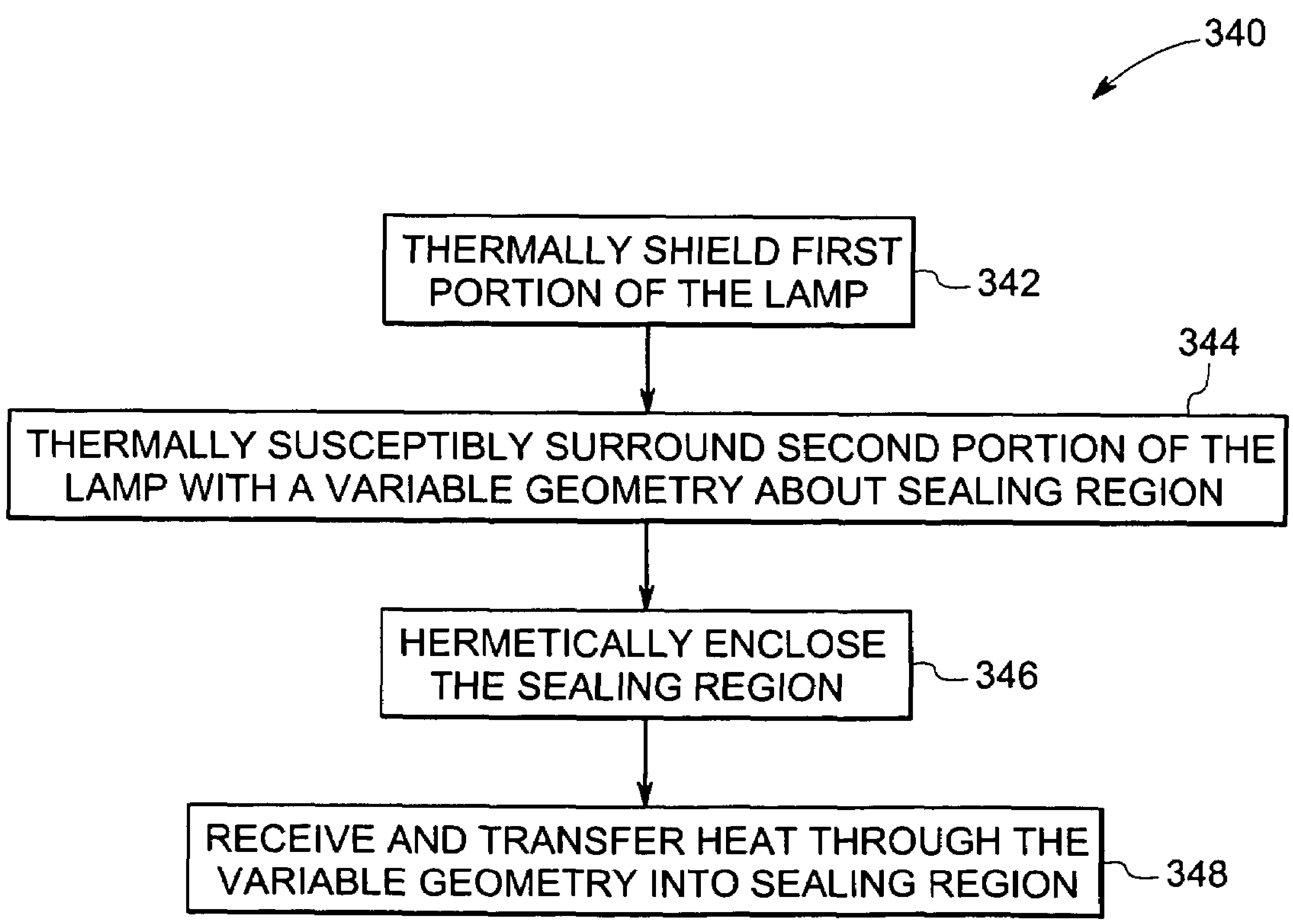
340
THERMALLY SHIELD FIRST PORTION OF THE LAMP
342
344
THERMALLY SUSCEPTIBLY SURROUND SECOND PORTION OF THE LAMP WITH A VARIABLE GEOMETRY ABOUT SEALING REGION
HERMETICALLY ENCLOSE THE SEALING REGION
346
RECEIVE AND TRANSFER HEAT THROUGH THE VARIABLE GEOMETRY INTO SEALING REGION
348

FIG.17

SYSTEM AND METHOD FOR SEALING HIGH INTENSITY DISCHARGE LAMPS

BACKGROUND

The invention relates generally to the field of lighting systems and, more particularly, to high-intensity discharge (HID) lamps. Specifically, embodiments of the present technique provide improved sealing features for such lamps.

High-intensity discharge lamps are often formed from a tubular body or arc tube that is sealed to one or more end structures. The tubular body may be made of any ceramic material, including polycrystalline alumina (PCA), sapphire, single crystal yttria aluminum garnet (YAG) and polycrystalline YAG. The end structures are often sealed to this ceramic tubular body using a seal glass, which has physical and mechanical properties matching those of the ceramic components and the end structures. Sealing usually involves heating the assembly of the ceramic tubular body, the end structures and the seal glass, to induce melting of the seal glass and a reaction with the ceramic bodies to form a strong chemical and physical bond. The ceramic tubular body and the end structures are often made of the same material. However, certain applications may require the use of different materials for the ceramic tubular body and the end structures. In either case, various stresses may arise due to the sealing process, the interface between the joined components, and the materials used for the different components. For example, the component materials may have different mechanical and physical properties, such as different coefficients of thermal expansion (CTE), which can lead to residual stresses and sealing cracks. These potential stresses and sealing cracks are particularly problematic for high-pressure lamps.

Additionally, the geometry of the interface between the ceramic tubular body and the end structures also may attribute to the foregoing stresses. For example, the end structures are often shaped as a plug or a pocket, which interfaces both the flat and cylindrical surfaces of the ceramic tubular body. If the components have different coefficients of thermal expansion and elastic properties, then residual stresses arise because of the different strains that prevent relaxation of the materials to stress-free states. For example in the case of the plug type end structure, if the plug has a lower coefficient of thermal expansion than the ceramic tubular body and seal glass, then compressive stresses arise in the ceramic-seal glass region while tensile stresses arise in the plug region.

Typically, the seal glasses used for sealing ceramic lamp components are required to be non-reactive with the different species in the lamp environment and to possess microstructural stability during the life of the lamp, in addition to having a melting temperature and a crystallization temperature above the lamp operating temperature. However, for high temperature lamp applications, these are challenging requirements.

In sealing techniques used currently, the seal glass is generally melted using a furnace cycle, such as a large muffle type furnace, with temperatures up to 1750 degrees centigrade. The seal glass and the ceramic components to be sealed are inserted into a base of the furnace and the furnace is operated through a controlled temperature cycle. The controlled temperature cycle is designed in conjunction with a temperature gradient at the end of the furnace to melt the seal glass (typically a dysprosia-alumina-silica mixture), which then flows through the gap between components to be sealed. The seal length is controlled in part by the temperature gradient.

The above approach may be disadvantageous in several respects. Firstly, the furnace used in the above described technique provides a relatively diffuse heat source with a low temperature gradient. Hence, the technique does not provide a desired control of seal length and seal microstructure. Further, the above technique may not be useful for a wide variety of lamp geometries. For example, in lamps having a short aspect ratio (i.e., ratio of length to diameter), an important consideration while sealing an end of the lamp is to preserve the dosing material inside the lamp. The above technique may prove disadvantageous in such applications, as the diffuse heat produced by the furnace may result in undesirable heating of the dosing material during sealing of one end of the lamp.

Accordingly, a technique is needed to provide a lighting system with improved sealing characteristics for sealing a wide variety of ceramic lamp components having varied geometries.

BRIEF DESCRIPTION

The present technique provides novel sealing systems and methods designed to respond to such needs. In one aspect, the present technique provides a system for sealing a lamp. The system includes a thermal shield and a thermally susceptible enclosure disposed adjacent the thermal shield. The thermal shield has a first receptacle adapted to receive a first portion of the lamp. The thermally susceptible enclosure includes a wall about a second receptacle adapted to receive a second portion of the lamp. The wall has a varying thickness in a desired sealing region between the first and second portions of the lamp.

In another aspect, the present technique provides a method of sealing a lamp. In accordance with an embodiment of this sealing method, a first portion of the lamp is thermally shielded. In addition, a second portion of the lamp is thermally susceptibly surrounded with a variable geometry along a desired sealing region between the first and second portions, the variable geometry being adapted to provide a variable heat susceptibility along the desired sealing region. The desired sealing region is hermetically enclosed. Heat is transferred radiatively through the variable geometry and into the desired sealing region with a variable heat profile based on the variable heat susceptibility. In yet another aspect, the present technique provides a lamp which is sealed by the above method.

DRAWINGS

These and other features, aspects, and advantages of the present invention will become better understood when the following detailed description is read with reference to the accompanying drawings in which like characters represent like parts throughout the drawings, wherein:

FIG. **1** is a cross-sectional view of an exemplary lamp wherein embodiments of the present technique are applicable;

FIG. **2** is a cross-sectional view of a system for sealing a lead wire to a dosing tube of the lamp using a radiative heat source having a pancake-shaped configuration that heats a susceptor having a varying wall thickness according to one embodiment of the present technique;

FIG. **3** is a cross-sectional view of a system for sealing a lead wire to a dosing tube of the lamp using a radiative heat source having an annular configuration that heats a susceptor having a varying wall thickness according to another embodiment of the present technique;

FIG. **4** is a cross-sectional view of a system for sealing a lead wire to a dosing tube of the lamp using a laser that heats a susceptor having a varying wall thickness according to yet another embodiment of the present technique;

FIG. **5** is a flow chart illustrating an exemplary seal process flow according to embodiments of the present technique;

FIG. **6** is a cross-sectional view of a system for sealing an end structure to an arc envelope of the lamp using a radiative heat source that heats a susceptor having a varying wall thickness according to embodiments of the present technique;

FIG. **7** is a cross-sectional view of a system for sealing an dosing tube to an end structure of the lamp using a radiative heat source that heats a susceptor having a varying wall thickness according to embodiments of the present technique;

FIG. **8** is a cross-sectional view of another exemplary lamp wherein embodiments of the present technique are applicable;

FIG. **9** is a cross-sectional view of a system for sealing a dosing tube to an arc envelope of the lamp illustrated in FIG. **8** using a radiative heat source that heats a susceptor having a varying wall thickness according to embodiments of the present technique;

FIG. **10** is a top view of a system for sealing a plurality of lamps including a plurality of susceptors having a varying wall thickness about the lamps in accordance with one embodiment of the present technique;

FIG. **11** is a cross-sectional side view of the system of FIG. **10** for sealing a plurality of lamps in accordance with embodiments of the present technique;

FIG. **12** is a top view of a system for sealing a plurality of lamps including a single susceptor having a varying wall thickness disposed about the plurality of lamps in accordance with another embodiment of the present technique;

FIG. **13** is a cross-sectional side view of the system of FIG. **12** for sealing a plurality of lamps in accordance with embodiments of the present technique;

FIG. **14** is a top view of a thermal cooling base having passages for circulation of a cooling fluid according to embodiments of the present technique;

FIG. **15** is a cross-sectional side view of the thermal cooling base of FIG. **14** in accordance with embodiments of the present technique;

FIG. **16** is a flow chart illustrating an exemplary method of manufacturing a lamp in accordance with embodiments of the present technique; and

FIG. **17** is a flow chart illustrating an exemplary method of sealing a lamp in accordance with embodiments of the present technique.

DETAILED DESCRIPTION

Aspects of the present technique provide unique sealing systems and methods for sealing between a wide variety of lamp components at high temperatures, for example, by providing localized heating and a high temperature gradient in the sealing region. Localized heating and a high temperature gradient minimize thermal stress in the components being sealed and substantially reduce or prevent cracking during heat-up, sealing, and cool-down stages of the sealing operation. Moreover, localized heating also aids retention of a lamp dose during the sealing operation. A high temperature gradient provides desirable microstructure control for both crystalline and glass phases of the seal. The unique features introduced above are described with respect to several exemplary embodiments of the present technique illustrated hereinafter.

Turning now to the drawings, FIG. **1** is a cross sectional view of an exemplary lamp **10** wherein aspects of the present technique are applicable. As illustrated, the lamp **10** comprises a hermetically sealed assembly of a hollow body or arc envelope **12** and end structures **14** and **16** coupled to opposite ends **18** and **20** of the arc envelope **12**, respectively. These and other components of the lamp **10** are formed from a variety of materials, which are either identical or different from one another. For example, different embodiments of the arc envelope **12** are formed from a variety of transparent ceramics and other materials, such as yttrium-aluminum-garnet (YAG), ytterbium-aluminum-garnet, microgram polycrystalline alumina (μPCA), alumina or single crystal sapphire, yttria, spinel, and ytterbia. Other embodiments of the arc envelope **12** are formed from conventional lamp materials, such as polycrystalline alumina (PCA). Turning to the end structures **14** and **16** of the lamp **10**, these components are formed from a variety of ceramics and other suitable materials, such as niobium, niobium coated with a corrosion resistant material (e.g., a halide resistant material), a cermet (e.g., an alumina-molybdenum cermet, an alumina-tungsten cermet, etc.), and other conductive or non-conductive materials depending on the particular embodiment described in detail below.

Regarding the geometry of the lamp **10**, certain embodiments of the arc envelope **12** comprise a hollow cylinder, a hollow oval shape, a hollow sphere, a bulb shape, a rectangular shaped tube, or another suitable hollow transparent body. Moreover, the end structures **14** and **16** may have a variety of geometries. In the illustrated embodiment the end structures **14** and **16** have a plug-shaped geometry that at least partially extends into the arc envelope **12**. Alternatively, some embodiments of the end structures may have a substantially flat mating surface, which butt-seals against the opposite ends **18** and **20** (i.e., end-to-end) without extending into the arc envelope **12**. The illustrated end structures **14** and **16** comprise outer seal structures **22** and **24** and inner seal structures **26** and **28**. The outer seal structures **22** and **24** of the end structure **14** and **16** abut and seal against the opposite ends **18** and **20** of the arc envelope **12**. The inner seal structures **26** and **28** plug into the opposite ends **18** and **20** and seal with inner surfaces of the arc envelope **12** adjacent the opposite ends **18** and **20**.

The lamp **10** is filled with a dosing material through one or more dosing tubes **30** and **32**. The dosing tubes **30** and **32** are disposed within dosing passageways **34** and **36** extending through the end structures **16** and **18**. In certain embodiments, these dosing tubes **30** and **32** are diffusion bonded or co-sintered to the end structures **16** and **18** within the dosing passageways **34** and **36**. Alternatively, embodiments of the dosing tubes **30** and **32** are bonded within the dosing passageways **34** and **36** using a sealing material, such as sealing materials **35** and **37**, respectively. Regarding the material composition, the dosing tubes **30** and **32** may comprise ceramics, such as alumina, sapphire, YAG, yttria, amongst others. As a result, dosing tubes **30** and **32** made of ceramics such as those mentioned above may be diffusion bonded to end structures **16** and **18** made of ceramics such as alumina, sapphire, YAG, etc. Alternatively, certain embodiments of the dosing tubes **30** and **32** may be formed of metals, such as niobium, molybdenum, amongst others. Inside the lamp **10**, certain embodiments of the dosing material include a rare gas and mercury. Other embodiments of the dosing material further comprise a halide, such as bromine, or a rare-earth metal halide.

The lamp **10** also includes arc electrodes **38** and **40** having arc tips **42** and **44**, respectively. Leading into the arc envelope **12**, the lamp **10** includes electrode lead wires **46** and **48**, which extend through the dosing tubes **30** and are in physical contact with the arc electrodes **38** and **40**, respectively. In alternate embodiments, one or more of the arc electrodes **38** or **40** may be mounted in receptacles (not shown) disposed in respective end structures **14** and **16**. In certain embodiments, the electrodes **38** and **40** may be inserted in support structures **50** and **52**, such as a coils, which are then mounted inside the dosing tubes **22** and **24**. The coils **50** and **52** support the arc electrodes **38** and **40** within the dosing tubes **30** and **32**, while also permitting some freedom of movement and stress relaxation of the respective components. The arc electrodes **38** and **40** are mounted such that the arc tips **42** and **44** are separated by a gap **54** to create an arc **56** during the operation of the lamp **10**. In certain embodiments, the lead wires **46** and **48** are formed from niobium and welded to the electrodes **38** and **40**, which are formed from molybdenum and are, in turn, welded to the arc tips **42** and **44** formed from tungsten. In a different embodiment, both lead wires and electrodes may be formed from molybdenum. Other embodiments of the electrodes **38** and **40**, the arc tips **42** and **44**, and the lead wires **46** and **48** comprise a variety of other suitable materials, including cermets, such as tungsten cermet, molybdenum cermet, or metals, such as tantalum, rhenium, amongst others.

Embodiments of the lamp **10** also have a variety of different lamp configurations and types, such as a high intensity discharge (HID) or an ultra high intensity discharge (UHID) lamp. For example, certain embodiments of the lamp **10** comprise a high-pressure sodium (HPS) lamp, a ceramic metal halide (CMH) lamp, a short arc lamp, a ceramic automotive lamp, an ultra high pressure (UHP) lamp, or a projector lamp. As mentioned above, components of the lamp **10** are uniquely sealed in accordance with aspects of the present technique described hereinafter. In certain embodiments of the present technique, a seal material, also referred to as frit or seal glass, is used between interfacing surfaces of the components to be sealed. The choice of the seal material is dependent on the configuration of the lamp, the operating temperatures and material compositions of the components to be sealed. Accordingly, depending upon the particular application, the seal material may comprise a wide variety of rare-earth oxide based seals such as yttrium aluminum silica (YAS) glass, dysprosia alumina silica seals, amongst others. In alternative embodiments, components having similar composition may be sealed via diffusion bonding of the materials at the interfacing surfaces of the components.

FIG. **2** illustrates a cross sectional view of an exemplary system **58** for sealing the electrode lead wire **46** of the lamp **10** to the dosing tube **30**, also referred to as a leg portion of the lamp **10**, in accordance with embodiments of the present technique. The system **58** includes a thermally susceptible enclosure **60** disposed on a base **62**. The thermally susceptible enclosure **60** has a receptacle **64** to receive a portion **66** of the lamp **10** including the electrode lead wire **46**. In the illustrated embodiment, a sealing material **68**, also referred to hereinafter as frit, is suitably shaped and positioned in a desired sealing region **70** between the lead wire **46** and the dosing tube **30**. In the illustrated embodiment, the thermally susceptible enclosure **60** includes a hollow thermal susceptor having a wall **72** surrounding the portion **66** of the lamp **10** including the lead wire **46**. In one embodiment, the thermally susceptible enclosure **60** is formed from graphite. In alternative embodiments, the thermally susceptible enclosure **60** may be formed of metals such as tungsten, molybdenum, tantalum, rhenium, or other suitable materials that are susceptible to heating by electromagnetic radiation, a laser beam, and so forth.

In the desired sealing region **70**, the wall **72** has a varying thickness **74** to control the heat profile or temperature gradient in the sealing region **70**, as discussed in further detail below. For example, the varying thickness **74** may have a linearly changing geometry, a curved geometry (e.g., concave, convex, exponential, etc.), a stepped geometry, or any other suitable geometry. As illustrated, a radiative heat source **76** emits heat or generally radiatively heats up the thermally susceptible enclosure **60**, which then radiates heat into the sealing region **70** with a desired temperature gradient or heat profile based on the varying thickness **74** of the wall **72**. For example, embodiments of the heat source **76** include an induction heating device, a laser, a resistance heating device, or a suitable device that radiates an emission that causes heating of the thermally susceptible enclosure **60**. In operation, the thermally susceptible enclosure **60** acts as a thermal collection and distribution device, which becomes heated by emissions from the radiative heat source **76** and then focuses the heat according to the varying thickness **74**. The heat radiated by the thermally susceptible enclosure **60** melts the frit **68**, which flows down through an annular gap **77** between the lead wire **46** and the dosing tube **30** to a depth (d), also referred to as seal length. In certain embodiments, sealing between the lead wire **46** and the dosing tube **30** may be achieved by material diffusion without any sealing material. In such embodiments, the heat radiated by the thermally susceptible enclosure **60** facilitates diffusion bonding of the materials at the interfacing surfaces of the lead wire **46** and the dosing tube **30** to produce a hermetical seal between one another.

The heat radiated by the thermally susceptible enclosure **60** has a varying profile in the sealing region **70** caused by the varying thickness **74** of the susceptor wall **72** in the sealing region **70**. In the illustrated embodiment, the thickness of the susceptor wall **72** increases with depth (d) in the sealing region **70**. Because of this varying thickness, a greater amount of heat is coupled to the lower portion of the variable geometry than the upper portion when the susceptor is heated by the radiative heat source **76**, thereby causing the thermally susceptible enclosure **60** to radiate more heat to the lower portion of the sealing region **70** than to the upper portion of the sealing region **70**. This variance establishes a high temperature gradient in the sealing region **70**, which aids in controlling the depth (d) of the seal. More specifically, the temperature gradient thus produced results in a low temperature near the base **62**, a high temperature in the sealing region **70** adjacent the thick part of the variable geometry, and a relatively lower temperature at the upper portion of the sealing region **70**, thereby preventing melting of the lead wire **46**. In certain embodiments where the lead wire **46** is formed from niobium, the depth (d) is controlled so as to cover the entire length of the niobium lead wire since niobium is reactive with certain dosing materials disposed inside the lamp **10**. Further, the high temperature gradient facilitates high sealing temperatures close to the melting point of the seal material **68** and provides desirable microstructure control of the crystalline and glass phases of the seal **68**. The temperature gradient may be measured via an optical pyrometer, a thermal imaging camera, a thermocouple system, and other methods of temperature measurement (such as paints, etc).

In cooperation with this localized temperature gradient in the sealing region **70**, the base **62** reduces undesirable heating in the adjacent components of the lamp **10**. In the illustrated embodiment, the base **62** includes a receptacle **78** to house a portion **80** of the lamp **10** including the dosing tube **30**. The base **62** is adapted to thermally shield or cool the portion **80** of the lamp **10** during the sealing process. This shielding or cooling substantially restricts or further localizes the high temperature to the sealing region **70**, rather than the adjacent portion **80** of the lamp **10**. This thermal shielding or cooling also reduces thermal stress in the arc envelope **12** and other components, and prevents formation of cracks therein. Further, the localized high temperature gradient, thus established, reduces heating of the dosing substance disposed within the lamp **10**. In certain embodiments, the base **62** is formed from a thermally conductive material including copper, copper alloys, molybdenum, tungsten, copper-tungsten alloys, graphite, among others, or combinations thereof. In these embodiments, the base **62** functions to transfer heat away from the portion **80** of the lamp **10**. The base **62** also may comprise a variety of cooling mechanisms, such as heat sinks, heat pipes, fans, circulating fluids, and so forth. Certain embodiments of the system **58** may include a thermally insulating layer **81** between the thermally susceptible enclosure **60** and the base **62**. The thermally insulating layer **81** substantially blocks heat transfer or radiative heat-generating emissions from the thermally susceptible enclosure **60** into the base **62** and the portion **80** disposed therein. The thermally insulating layer **81** may comprise an air gap, radiation shields, or thermally insulating materials, such as alumina, yttria, yttria stabilized zirconia, amongst other materials.

In addition to the thermally susceptible enclosure **60** and the base **62**, the system **58** is hermetically sealed by an outer enclosure **82** surrounding the thermally susceptible enclosure **60** and disposed over the base **62**. The system **58** may include a variety of sealing mechanisms, such as gaskets, O-rings, amongst others. In certain embodiments, the outer enclosure **82** is formed from a material including quartz, glass, Pyrex, steel, stainless steel, aluminum, copper, among others, or combinations thereof. The outer enclosure **82** may be filled with an inert gas, such as xenon, crypton, argon, among others, such that the sealing region **70** is surrounded by the inert gas. In this manner, the inert gas prevents undesirable oxidation of metallic lead wire components, metallic furnace components such as the susceptor, and so forth. Alternatively, the system **58** may create a vacuum inside the hermetically sealed outer enclosure **82**. In this manner, the outer enclosure **82** facilitates an air-tight seal for the system **58**.

In the illustrated embodiment, the heat source **76** includes a radio frequency (RF) induction coil **84** coupled to a source **86** of radio frequency (RF) power. The RF induction coil **84** is energized by passing an alternating current (AC) through the induction coil **84** via the power source **86**. In one embodiment, the alternating current has a frequency of 250 KHz. The choice of frequency of the alternating current depends upon the design of the thermally susceptible enclosure **60**. In certain embodiments, the frequency may range from about 50 Hz to about 2 MHz. The alternating current generates an electromagnetic field, which induces a current in the thermally susceptible enclosure **60**. The thermally susceptible enclosure **60** is heated in the process and radiates heat to the sealing region **70** as described above.

The power source **86** may be controlled to establish a desired sealing temperature. In one embodiment, the sealing temperature is 1875 degrees centigrade. In certain embodiments of the present technique, the sealing temperature may range from about 1000 degrees centigrade to about 1950 degrees centigrade. The power source **86** may also be controlled to provide a desired time profile of the heating cycle. In one embodiment, the sealing temperature is maintained at 1475 degrees centigrade for approximately one minute of operation. The sealing temperature is then raised from 1475 degrees centigrade to 1875 degrees centigrade over a period of approximately 40 seconds, and is then maintained at 1875 degrees centigrade for about 30 seconds. The sealing region **70** is subsequently cooled or quenched to produce a hermetical seal between the lead wire **46** and the dosing tube **30**. The rate of quenching is dependent on the particular components being sealed and the particular sealing material used, if any.

In the embodiment illustrated in FIG. **2**, the induction coil **84** has a pancake configuration and is positioned aside the sealing region **70** outside the outer enclosure **82**. Alternatively, FIG. **3** illustrates a system **88** having a radiative heat source **90** including a power source **91** coupled to an induction coil or solenoid coil **92** that annularly encircles the sealing region **70**. However, the coils may have a variety of configurations and features in accordance with embodiments of the present technique.

It should be appreciated that other radiative heat sources that provide local heating of the sealing region **70** are also within the scope of the present technique. For example, FIG. **4** illustrates a system **94** having a radiative heat source **96** that includes a laser **98**. The laser **98** is operable to produce a beam **100**, which may be focused onto the thermally susceptible enclosure **60** in the sealing region **70**. The thermally susceptible enclosure **60** absorbs the energy of the laser beam **100**, and radiates heat to the desired sealing region **70**.

FIG. **5** is a flow chart illustrating an exemplary sealing process for the lamp **10** in accordance with embodiments of the present technique. The sealing process **102** begins by assembling ceramic components of the lamp such as the arc envelope, ends structures, and dosing tubes (block **103**). Block **103** may also include assembling an electrode assembly comprising the electrode tip, the arc electrode, and the electrode lead. At block **104**, the process **102** continues by assembling the electrode lead, the ceramic leg portion or the dosing tube, and the sealing material. One end of the lamp is then sealed (block **106**). Block **106** includes sealing the electrode lead wire **46** to the dosing tube **30** as described above. Specifically, block **106** includes heating up a susceptor having a varying wall thickness, which then radiates heat with a desired heat profile toward the components being sealed. The block **106** may also include cooling or quenching of the sealing region. The lamp is then filled with a dosing material such as any of those mentioned above (block **108**). At block **110**, the other end of the lamp **10** is sealed. This may include sealing the electrode lead wire **48** to the dosing tube **32** in a similar manner as described above for sealing the electrode lead wire **46** to the dosing tube **30**. Again, the block **110** may include heating a susceptor having a varying wall thickness, which then radiates heat with a desired heat profile toward the components being sealed. The sealing region on the other end may be subsequently cooled or quenched.

As discussed above, various embodiments of the present technique can be employed to seal a wide variety of lamp components. For example, an embodiment of the present technique can be used to seal an end structure to an arc envelope. Referring now to FIG. **6**, a system **112** is illustrated for sealing the end structure **14** of the lamp **10** to the arc envelope **12**. The system **112** includes a hollow susceptor **114** having a receptacle **116** to receive a portion **118** of the lamp **10** including the end structure **14**. The susceptor **114** is disposed on a base **120** having a receptacle **122** to receive another portion **124** of the lamp **10** including the arc envelope **12**. A frit **126** is suitably disposed in a sealing region **128** between the end structure **14** and the arc envelope **12**. As described above, in certain embodiments, no sealing material is disposed between the end structure **14** and the arc envelope **12** and sealing between them is achieved by diffusion bonding. Similar to the earlier embodiment, the susceptor **114** has a wall **130**, which has a varying thickness **132** in the sealing region **128**. For example, the varying thickness **132** may have a linearly changing geometry, a curved geometry (e.g., concave, convex, exponential, etc.), a stepped geometry, or any other suitable geometry. The system **112** may include a thermally insulating layer **134** as described earlier, to block heat transfer or radiative heat-generating emissions from the susceptor **114** into the base **120** and the portion **124** disposed therein. The system **112** is further hermetically sealed by an outer enclosure **136**, which may be internally in vacuum or filled with an inert gas in certain embodiments. A radiative heat source **138** is provided to radiate heat or heat-generating emissions to the susceptor **114**. In turn, the heated susceptor **114** radiates heat toward the sealing region **128**, thereby creating a varying heat profile to melt the frit **126** or to facilitate material diffusion at the interfacing surfaces of the end structure **14** and the arc envelope **12**. As described above, the heat radiated by the susceptor **114** has a varying profile in the sealing region **128** to provide a high temperature gradient in the sealing region **128**, thereby controlling the depth and other characteristics of the seal. In the illustrated embodiment, the heat source **138** includes a radio frequency power source **140** coupled to an induction coil **142** having a pancake configuration. However, as described above, the radiative heat source **138** may have several alternative embodiments.

According to a further embodiment, the present technique can be employed to seal a dosing tube or a leg portion to an end structure. FIG. **7** illustrates a system **144** for sealing the dosing tube **30** to the end structure **14**. The system **144** includes a hollow thermal susceptor **146** having a receptacle **148** to receive a portion **150** of the lamp **10** including the dosing tube **30**. A base **152** is disposed adjacent the susceptor **146** and has a receptacle **154** to receive another portion **156** of the lamp **10** including the end structure **14**. A frit **158** is suitably disposed in a sealing region **160** between the end structure **14** and the dosing tube **30**. Alternatively, the dosing tube **30** may be sealed to the end structure **14** by diffusion bonding without the use of the frit or sealing material **158**. The wall **162** of the susceptor **146** has a varying thickness **164** in the sealing region **160**. For example, the varying thickness **164** may have a linearly changing geometry, a curved geometry (e.g., concave, convex, exponential, etc.), a stepped geometry, or any other suitable geometry. The system **144** may include a thermally insulating layer **165** as described earlier, to block heat transfer or radiative heat-generating emissions from the susceptor **146** into the base **152** and the portion **156** disposed therein. The system **144** is hermetically sealed by an outer enclosure **166**, which may be internally in vacuum or filled with an inert gas in certain embodiments. Heat or a heat-generating emission is radiated by a radiative heat source **168** to the susceptor **146**, which in turn radiates heat with a varying heat profile into the sealing region **160**. As a result, the varying heat profile melts the frit **158** or to facilitate material diffusion at the interfacing surfaces of the dosing tube **30** and the end structure **14** in the sealing region **160**, thereby producing a hermetical seal between the end structure **14** and the dosing tube **30**. As described above, the heat radiated by the susceptor **146** has a varying profile in the sealing region **160** to provide a high temperature gradient in the sealing region **160**, thereby controlling the depth and other characteristics of the seal. Again, the illustrated embodiment of the heat source **168** includes a radio frequency power source **170** coupled to an induction coil **172** having a pancake configuration. However, several different embodiments of the radiative heat source **168** are within the scope of the present technique.

In certain embodiments, the dosing tube and/or the electrodes are coupled directly into the arc envelope. Embodiments of the present technique can be used to seal the dosing tube to the arc envelope in such lamps. FIG. **8** illustrates a cross-sectional view of an exemplary lamp **174** as described above wherein aspects of the present technique are applicable. The lamp **174** has a hollow body or arc envelope **176** which has opposite receptacles or open ends **178** and **180**, e.g., integral open end structures. In the illustrated embodiment, the arc envelope has a generally curved or round geometry. In certain embodiments, the arc envelope **176** has an elliptical, oval, spherical, oblong, bulb-shaped, dome-shaped, tubular, or other desired geometry. Dosing tubes **182** and **184** are fitted into the open ends **178** and **180**. Additionally, lead wires **186** and **188** extend through the dosing tubes **182** and **184** to the arc envelope **176**. In turn, the lead wires **186** and **188** extend to arc electrodes **190** and **192** having tips **194** and **196** disposed within the arc envelope **176**.

Referring now to FIG. **9**, this figure illustrates a system **198** for sealing the dosing tube **182** to the arc envelope **176** of the lamp **174** of FIG. **8** in accordance with embodiments of the present technique. The system **198** includes a hollow susceptor **200** disposed on a base **202**. A receptacle **204** in the susceptor **200** receives a portion **206** of the lamp **174** including the dosing tube **182**. The base **202** has a receptacle **208** to receive another portion **210** of the lamp **174** including the arc envelope **176**. A frit **212** is suitably positioned in a sealing region **214** between the dosing tube **182** and the arc envelope **176**. As described above, in certain embodiments, no sealing material is disposed between the dosing tube **182** and the arc envelope **176**, and sealing between them is achieved by diffusion bonding. The susceptor **200** has a wall **216**, which surrounds the portion **206** of the lamp **174** and has a varying thickness **218** in the sealing region **214**. For example, the varying thickness **218** may have a linearly changing geometry, a curved geometry (e.g., concave, convex, exponential, etc.), a stepped geometry, or any other suitable geometry. The system **198** may include a thermally insulating layer **219** as described earlier, to block heat transfer or radiative heat-generating emissions from the susceptor **200** into the base **202** and the portion **210** disposed therein. The system **198** is hermetically sealed by an outer enclosure **220**, which may be internally in vacuum or filled with an inert gas in certain embodiments. A radiative heat source **222** having an RF power source **224** coupled to an induction coil **226** is employed to heat the susceptor **200**. In turn, the heat susceptor **200** radiates heat into the sealing region **214** to melt the frit **212** or to facilitate material diffusion at the interfacing surfaces of the dosing tube **182** and the arc envelop **176**, thereby producing a hermetical seal between one another. As can be appreciated, several embodiments of the radiative heat source **222** may fall within the scope of the present technique. As described above, the heat radiated by the susceptor **200** has a varying profile in the sealing region **214** to provide a high temperature gradient in the sealing region **214**. This temperature gradient controls the depth and other characteristics of the seal.

Certain embodiments of the present technique provide sealing systems to seal a plurality of lamps in one sealing cycle. Referring to FIGS. **10** and **11**, these figures illustrate a system **228** for sealing a plurality of lamps in accordance with certain embodiments of the present technique. FIG. **10** is a top view of the system **228**, while FIG. **11** is a cross sectional view of the system **228** along the section **11-11** of FIG. **10**. Referring generally to FIGS. **10** and **11**, the illustrated system **228** can be used to seal four lamps in one sealing cycle. The system **228** includes a base **230** having receptacles **232**, **234**, **236** and **238** adapted to receive a first portion of each of the lamps **240**, **242**, **244** and **246**, respectively. The system also includes thermally susceptible enclosures or susceptors **248**, **250**, **252** and **254** having receptacles **256**, **258**, **260** and **262** adapted to receive a second portion of the lamps **240**, **242**, **244** and **246**, respectively. As in the earlier embodiments, the susceptors **248**, **250**, **252** and **254** have walls **264**, **266**, **268** and **270** having a varying thickness in sealing regions **272**, **274**, **276** and **278**, respectively (see FIG. **11**). The system **228** may include thermally insulating layers **273**, **275**, **277**, **279** to block heat transfer or radiative heat-generating emissions from the susceptors **248**, **250**, **252**, **254** into the base **230**. The system **228** further includes an outer enclosure **280** to substantially seal the sealing region therein. Moreover, the outer enclosure **280** may be in vacuum or filled with an inert gas to reduce undesirable effects of thermally sealing the lamps. The susceptors **248**, **250**, **252** and **254** are heated by a radiative heat source **282**, which may include an RF power source **284** coupled to an induction coil **286**, amongst other embodiments of the radiative heat source. In certain embodiments, heating of the susceptors **248**, **250**, **252** and **254** is facilitated via rotation of the induction coil **286** about the enclosure **280**. In alternative embodiments, the base **230** may rotatable to facilitate heating of the susceptors **248**, **250**, **252** and **254** by the induction coil. In further embodiments, both the base **230** and the induction coil **286** may be rotated to facilitate heating of the susceptors **248**, **250**, **252** and **254**. In yet another embodiment, the induction coil may comprise a solenoid that annularly encircles the outer enclosure **280**. The susceptors **248**, **250**, **252** and **254** then radiate heat to the respective sealing regions **272**, **274**, **276** and **278**. Again, the varying thicknesses of the walls **264**, **266**, **268**, and **270** facilitate a varying heat profile, which provide desirable sealing characteristics as discussed above.

In a different embodiment of the above technique, a single susceptor having multiple receptacles may be used in place of multiple susceptors. Such an embodiment is illustrated referring generally to FIGS. **12** and **13**. FIG. **12** illustrates a top view of a system **288** according to the above embodiment. FIG. **13** is a cross sectional view of the system **288** along a section cut by the plane **13-13** in FIG. **12**. Referring generally to FIGS. **12** and **13**, the system **288** is configured similarly to the system **228** of FIGS. **10** and **11**. However, the system **288** illustrated in FIGS. **12** and **13** includes a single susceptor **290** disposed on the base **230**. As further illustrated in FIG. **13**, the susceptor **288** has a wall **292** of varying thickness to facilitate a varying heat profile, which controls the sealing characteristics in the components being sealed. The susceptor **290** in the illustrated embodiment has receptacles **294**, **296**, **298** and **300** to accommodate the second portions of the lamps **240**, **242**, **244** and **246**, respectively. In the illustrated embodiment, the susceptor **290** is heated by an annular shaped radiative heat source **301** including an RF power source **302** coupled to a solenoid coil **303** annularly encircling the outer enclosure **280**. The system **288** may include a thermally insulating layer **304** to block heat transfer or radiative heat-generating emissions from the susceptors **248**, **250**, **252**, **254** into the base **230**.

FIGS. **14** and **15** illustrate an exemplary base **305** used for sealing a lamp in accordance with embodiments of the present technique. FIG. **14** represents a top view while FIG. **15** represents a cross sectional view of the base **305** along the section **15-15**. As illustrated, the base **305** has a receptacle **306**, which extends axially through the base **302**. The receptacle **306** is adapted to receive a portion of the lamp to be thermally shielded or cooled during the sealing process. Accordingly, the shape and/or size of the receptacle **306** may vary depending upon the components of the lamp to be sealed. In the illustrated embodiment, the base **305** also includes an annular circumferential passage **307** for circulation of a cooling fluid. The base **304** also includes passages **308**, **310**, **312** and **314** parallel to an axial direction and adapted to facilitate entry and exit of the cooling fluid through the annular passage **307**. Accordingly, the passages **308**, **310**, **312** and **314** may be coupled to respective fluid inlets **316**, **318**, **320** and **321** and respective fluid outlets **322**, **324**, **326** and **328**, or vice versa. In the illustrated embodiment, the passages **308**, **310**, **312** and **314** are coupled to fluid inlets at the top and fluid outlets at the bottom. In a different embodiment, the passages **308**, **310**, **312** and **314** may be coupled to fluid inlets at the bottom and fluid outlets at the top. In one embodiment, the cooling fluid is water. In another embodiment, the cooling fluid may include a liquefied gas, such as liquid nitrogen. Other examples of the cooling fluid may include water-oil mixture, water-glycol mixture, or liquid metals, such as tin, lead, tin-lead alloys, sodium-potassium alloys, amongst others. The above embodiment is advantageous because liquid nitrogen provides sufficient cooling of the arc envelope to freeze certain undesirable elements such as xenon, which may be present in certain embodiments of the dosing material disposed inside the lamp.

FIG. **16** is a flow chart illustrating an exemplary process **330** of manufacturing a lamp in accordance with embodiments of the present technique. With reference to the lamps described above with reference to FIG. **1** and FIG. **8** among others, the process **330** begins by inserting a first portion of the lamp into a receptacle of a base (block **332**). The base is adapted to provide a thermal shield and/or cooling to the first portion of the lamp. At block **334**, the process **330** proceeds by positioning a thermally susceptible enclosure, such as a susceptor, over a second portion of the lamp and adjacent to the base. The thermally susceptible enclosure has a wall, which includes at least a portion having a varying thickness. The process positions the thermally susceptible enclosure such that the portion of the wall having the varying thickness is disposed about a sealing region between the first and the second portions of the lamp. At block **336**, the process **330** continues by placing an external enclosure about the thermally susceptible enclosure to provide a hermetically sealed chamber about the desired sealing region therein. The block **336** also may include configuring the interior of the external enclosure to be in vacuum or filled with an inert gas. At block **338**, the process **330** proceeds by radiating heat or heat-generating emissions through the external enclosure and into the thermally conductive enclosure thermally susceptible enclosure. As explained above, this radiation causes the thermally susceptible enclosure to heat up and, in turn, radiate heat into the desired sealing region with a variable heat profile based on the varying thickness. Further, as explained in detail above, the first and second portions of the lamp can include a dosing tube, an arc envelope, an end structure, a lead wire, or any combinations thereof.

FIG. **17** is a flow chart illustrating an exemplary process **340** of sealing a lamp in accordance with embodiments of the present technique. With reference to the lamps described above with reference to FIG. **1** and FIG. **8** among others, the process **340** begins by thermally shielding a first portion of the lamp (block **342**). The act of thermally shielding may include blocking heat, dissipating heat, or generally reducing undesirable heating of the first portion of the lamp. For example, block **342** may include positioning the first portion of the lamp in a receptacle of a base, which provides a thermal shield and/or cooling mechanisms about the first portion of the lamp. At block **344**, the process **340** continues by thermally susceptibly surrounding a second portion of the lamp with a variable geometry along a desired sealing region between the first and second portions. The variable geometry is adapted to provide variable heat susceptibility along the desired sealing region. At block **346**, the process **340** proceeds by hermetically enclosing the desired sealing region. Embodiments of block **346** include enclosing the sealing region in vacuum or with a desired substance, such as an inert gas. At block **348**, the process **340** continues by radiatively receiving and transferring heat through the variable geometry and into the desired sealing region with a variable heat profile based on the variable heat susceptibility. As described in detail above, block **348** may include melting of a seal material such that the seal material flows in the desired sealing region between the first and the second portions of the lamp. Alternatively, block **348** may include diffusion bonding the first or the second portions of the lamp in the desired sealing region.

As will be appreciated, various embodiments of the present technique can be used to seal a wide variety of lamp components. Such components may have varied geometries and may include, for example, arc envelopes, dosing tubes or passageways, electrode lead wires, end structures, amongst others. An important advantage of the present technique is that it can be used for arc tubes and other components having a wide variety of material composition.

While only certain features of the invention have been illustrated and described herein, many modifications and changes will occur to those skilled in the art. It is, therefore, to be understood that the appended claims are intended to cover all such modifications and changes as fall within the true spirit of the invention.

The invention claimed is:

1. A system for sealing a lamp, comprising:

a thermal control structure having a first receptacle adapted to receive a first portion of the lamp; and

a thermally susceptible enclosure disposed adjacent the thermal control structure, wherein the thermally susceptible enclosure comprises a wall about a second receptacle adapted to receive a second portion of the lamp, wherein the wall has a varying thickness in a desired sealing region between the first and second portions of the lamp.

2. The system of claim **1**, wherein the thermal control structure is adapted to substantially reduce heating of a dosing substance disposed within the lamp.

3. The system of claim **1**, wherein the varying thickness is adapted to provide a desired heat profile in the desired sealing region.

4. The system of claim **1**, further comprising an outer sealing enclosure disposed about the thermally susceptible enclosure adjacent the thermal control structure, wherein the outer sealing enclosure is adapted to substantially seal the desired sealing region therein.

5. The system of claim **4**, comprising an inert gas disposed inside the outer sealing enclosure in pneumatic communication with the desired sealing region.

6. The system of claim **4**, further comprising a radiative heat source disposed outside the outer sealing enclosure, the radiative heat source being adapted to radiate emissions through the outer sealing enclosure and into the thermally susceptible enclosure, wherein the thermally susceptible enclosure is adapted to become heated by the emissions and to radiate heat into the desired sealing region in a varying heat profile based on the varying thickness.

7. The system of claim **6**, wherein the radiative heat source comprises a radio frequency (RF) heating device.

8. The system of claim **6**, wherein the radiative heat source comprises a laser.

9. The system of claim **1**, wherein the thermal control structure has a fluid passage adapted to circulate a fluid for cooling the first portion of the lamp.

10. The system of claim **9**, wherein the fluid passage comprises a passageway extending substantially around the first receptacle.

11. The system of claim **9**, comprising a liquefied gas source coupled to the fluid passage.

12. The system of claim **1**, wherein the thermal control structure comprises a material including copper.

13. The system of claim **1**, wherein the thermally susceptible enclosure comprises graphite.

14. The system of claim **1**, wherein the first portion or the second portion comprises an arc envelope, an end structure, a dosing tube, or an electrode lead wire, or any combination thereof.

15. A system for sealing a lamp, comprising:

a thermal control structure having a first receptacle adapted to receive a first portion of the lamp;

a thermally susceptible enclosure disposed adjacent the thermal control structure, wherein the thermally susceptible enclosure comprises a wall adapted to substantially surround a second portion of the lamp, wherein the wall has a varying thickness in a desired sealing region between the first and second portions of the lamp;

an outer sealing enclosure disposed about the thermally susceptible enclosure adjacent the thermal control structure; and

a radiative heat source adapted to radiate emissions into the thermally susceptible enclosure, wherein the thermally susceptible enclosure is adapted to become heated by the emissions and to radiate heat into the desired sealing region in a varying heat profile based on the varying thickness.

16. The system of claim **15**, wherein the thermal control structure is adapted to substantially reduce heating of a dosing substance disposed within the lamp.

17. The system of claim **15**, wherein the thermally susceptible enclosure comprises graphite.

18. The system of claim **15**, wherein the thermal control structure comprises a fluid passage adapted to circulate a fluid for cooling the first portion of the lamp.

19. The system of claim **15**, wherein the radiative heat source comprises a radio frequency (RF) heating device.

20. The system of claim **19**, wherein the radio frequency (RF) heating device comprises a pancake-configured coil adapted to be positioned aside the desired sealing region.

21. The system of claim **19**, wherein the radio frequency (RF) heating device comprises an annularly-configured coil adapted to encircle the desired sealing region.

22. The system of claim **15**, wherein the radiative heat source comprises a laser.

23. The system of claim **15**, wherein the first portion or the second portion comprise a ceramic material including polycrystalline alumina, sapphire, single crystal yttrium aluminum garnet, or polycrystalline yttrium aluminum garnet, or any combination thereof.

24. The system of claim **15**, wherein the first portion comprises an end structure and the second portion comprises a dosing tube.

25. The system of claim **15**, wherein the first portion comprises an arc envelope and the second portion comprises an end structure.

26. The system of claim **15**, wherein the first portion comprises a dosing tube and the second portion comprises an electrode lead wire.

27. A system for sealing a plurality of lamps, comprising:

a thermal control structure having a first plurality of receptacles adapted to receive a first portion of each of the plurality of lamps, respectively; and

a thermally susceptible enclosure disposed adjacent the thermal control structure, wherein the thermally susceptible enclosure comprises a wall about a second portion of each of the plurality of lamps, wherein the wall has a varying thickness in a desired sealing region between the first and second portions of the plurality of lamps.

28. The system of claim **27**, wherein the varying thickness is adapted to provide a desired heat profile in the desired sealing region.

29. The system of claim **27**, comprising a separate thermally susceptible enclosure for each of the plurality of lamps, each of the separate thermally susceptible enclosures having a varying wall thickness in a sealing region between the first and second portions of one of the plurality of lamps.

30. The system of claim **27**, wherein the thermally susceptible enclosure comprises a second plurality of receptacles adapted to receive the second portion of each of the plurality of lamps, respectively, each of the second plurality of receptacles having a varying wall thickness in a sealing region between the first and second portions.

31. The system of claim **27**, further comprising an outer sealing enclosure disposed about the thermally susceptible enclosure adjacent the thermal control structure, wherein the outer sealing enclosure is adapted to substantially seal the desired sealing region of the plurality of lamps therein.

32. The system of claim **27**, further comprising a radiative heat source adapted to radiate emissions into the thermally susceptible enclosure, wherein the thermally susceptible enclosure is adapted to become heated by the emissions and to radiate heat into the desired sealing region in a varying heat profile based on the varying thickness.

33. The system of claim **32**, wherein the radiative heat source comprises an induction heating device, a laser, or a resistance heating device.

34. The system of claim **32**, wherein the radiative heat source comprises a radio frequency induction coil coupled to a source of radio frequency power.

35. The system of claim **32**, wherein the radiative heat source comprises a laser.

36. The system of claim **32**, wherein the radiative heat source comprises a power source coupled to a coil that annularly encircles the desired sealing region.

37. A system for sealing a lamp, comprising: means for controlling heat transfer in a first portion of the lamp; and means for radiating heat collected from a radiative heat source through a varying thickness wall to a second portion of the lamp in a desired sealing region between the first and second portions of the lamp, the heat having a variable heat profile in the desired sealing region.

38. The system of claim **37**, comprising means for externally enclosing the desired sealing region.

39. The system of claim **37**, comprising means for generating heat at the radiative heat source.

40. A method of manufacturing a lamp, comprising:

inserting a first portion of the lamp into a receptacle of a thermal control structure;

positioning a thermally susceptible enclosure about a second portion of the lamp adjacent the thermal control structure, such that a varying thickness of the thermally susceptible enclosure is disposed about a desired sealing region between the first and second portions;

placing an external enclosure about the thermally susceptible enclosure to provide a hermetically sealed chamber about the desired sealing region; and

radiating emissions through the external enclosure and into the thermally susceptible enclosure, such that the thermally susceptible enclosure becomes heated by the emissions and radiates heat into the desired sealing region with a variable heat profile based on the varying thickness.

41. The method of claim **40**, further comprising circulating a fluid within the thermal control structure for cooling the first portion of the lamp.

42. The method of claim **40**, wherein radiating emissions comprises generating heat from a radio frequency (RF) heating device.

43. The method of claim **40**, wherein radiating emissions comprises generating heat from a laser.

44. The method of claim **40**, wherein inserting the first portion of the lamp comprises inserting an arc envelope, an end structure, or a dosing tube, or any combination thereof.

45. The method of claim **40**, wherein positioning the thermally susceptible enclosure about the second portion of the lamp comprises positioning the thermally susceptible enclosure about an electrode lead wire, a dosing tube, or an end structure, or any combination thereof.

46. The method of claim **40**, wherein the first and second portions comprise an electrode lead wire and a dosing tube, a dosing tube and an end structure, or an end structure and an arc envelope, respectively.

47. A lamp formed by the method of claim **40**.

48. A method of sealing a lamp, comprising:

thermally shielding a first portion of the lamp;

thermally susceptibly suffounding a second portion of the lamp with a variable geometry along a desired sealing region between the first and second portions, the variable geometry adapted to provide a variable heat susceptibility along the desired sealing region;

hermetically enclosing the desired sealing region; and

radiatively receiving and transfeffing heat through the variable geometry and into the desired sealing region with a variable heat profile based on the variable heat susceptibility.

49. The method of claim **48**, further comprising fluid cooling the first portion of the lamp.

50. The method of claim **48**, wherein thermally shielding the first portion of the lamp comprises thermally shielding an arc envelope, an end structure, or a dosing tube, or any combination thereof.

51. The method of claim **48**, wherein thermally susceptibly surrounding the second portion of the lamp comprises thermally susceptibly surrounding an electrode lead wire, a dosing tube, or an end structure, or any combination thereof.

52. The method of claim **48**, wherein the first and second portions comprise an electrode lead wire and a dosing tube, a dosing tube and an end structure, or an end structure and an arc envelope, respectively.

53. The method of claim **48**, comprising generating heat from a radio frequency (RF) heating device directed toward the desired sealing region.

54. The method of claim **48**, wherein radiatively receiving and transferring heat comprises diffusion bonding the first and second portions in the desired sealing region.

55. The method of claim **48**, wherein radiatively receiving and transferring heat comprises at least partially flowing a seal material in the desired sealing region between the first and second portions.

56. The method of claim **48**, wherein radiatively receiving and transferring heat comprises end-to-end sealing the first and second portions in the desired sealing region.

57. The method of claim **48**, comprising surrounding the desired sealing region with an inert gas.

58. A lamp formed by the method of claim **44**.

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